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UNIVERSAL REMOTE INCLUDING APPARATUS USING COMPRESSED CODES FOR VIDEO RECORDER CONTROL

Background of the Invention

This is a continuation in part of pending Patent Application Serial No. 07/965,075 filed October 22, 1992, which is a continuation of pending Patent Application Serial No. 07/877,687 filed May 1, 1992, now abandoned, which is a continuation in part of Patent Application Serial No. 07/829,412 filed February 3, 1992, which is a continuation in part of Serial No. 07/767,323 filed September 30, 1991, which is a continuation in part of Serial No. 07/676,934 filed March 27, 1991, which is a continuation in part of Serial No. 07/371,054 filed June 26, 1989, now abandoned, which itself is a continuation in part of Serial No. 07/289,369, filed December 23, 1988, now abandoned.

Field of the Invention

This invention relates generally to video cassette recorder systems and particularly to an apparatus and method for using encoded information to shorten the time required to perform timer preprogramming and for remotely controlling various home electronic devices and an alternate apparatus and method that itself is easily programmable.

Prior Art

The video cassette recorder (VCR) has a number of uses, including playing back of tapes filmed by a video camera, playing back of pre-recorded tapes, and recording and playing back of broadcast and cable television programs.

To record a television program in advance of viewing it, a two-step process is often used: (1) obtain the correct channel, date, time and length (CDTL) information from a television program guide, and (2) program this CDTL information into the VCR. Depending on the model, year and type of the VCR, the CDTL information can be programmed in various ways including: (i) pushing an appropriate sequence of keys in the console according to instructions contained in the user's manual, (ii) pushing an appropriate sequence of keys in a remote hand-held control unit according to instructions contained in the user's manual (remote programming), and (iii) executing a series of keystrokes in the remote hand-held control unit in response to a menu displayed on the television screen (on-screen programming). Other techniques for timer preprogramming have been suggested including: (iv) reading in certain bar-code information using a light pen (light pen programming), and (v) entering instructions through a computer or telephone modem. These various methods differ only in the physical means of specifying the information while the contents, being CDTL and certain power/clock/timer on-off commands are generally common although the detailed protocol can vary with different model VCRs. Methods (i) and (ii) described above can require up to 100 keystrokes, which has inhibited the free use of the timer preprogramming feature of VCRs. To alleviate this, new VCR models have included an "On-Screen Programming" feature, which permits remote input of CDTL information in response to a menu displayed on the television screen. Generally on screen programming of CDTL information requires an average of about 18

keystrokes, which is less than some of the prior methods but still rather substantial. Some of the other techniques such as (iv) above, require the use of special equipment such as a bar code reader.

In general the present state of the art suffers from a number of drawbacks. First, the procedure for setting the VCR to record in advance can be quite complex and confusing and difficult to learn; in fact, because of this many VCR owners shun using the timer preprogramming record feature. Second, the transcription of the CDTL information to the VCR is hardly ever error-free; in fact, many users of VCR's timer preprogramming features express concern over the high incidence of programming errors. Third, even for experienced users, the process of entering a lengthy sequence of information on the channel, date, time and length of desired program can become tedious. Fourth, techniques such as reading in bar-code information or using a computer require special equipment. These drawbacks have created a serious impedance in the use of a VCR as a recording device for television programs. The effect is that time shifting of programs has not become as popular as it once was thought it would be. Accordingly, there is a need in the art for a simpler system for effecting VCR timer preprogramming which will enable a user to take advantage of the recording feature of a VCR more fully and freely.

Summary of the Invention

A principal feature of the invention is providing an improved system for the selection and entering of channel, date, time and length (CDTL) information required for timer preprogramming of a VCR which is substantially simpler, faster and less error-prone than present techniques. Another principal feature of the invention is providing televisions having an embedded capability for timer programming control.

In accordance with the invention, to program the timer preprogramming feature of a video system, there is an apparatus and method for using encoded video recorder/player timer preprogramming information. The purpose is to significantly reduce the number of keystrokes required to set up the timer preprogramming feature on a VCR. In accordance with this invention it is only necessary for the user to enter a code with 1 to 7 digits or more into the VCR. This can be done either remotely or locally at the VCR. Built into either the remote controller or the VCR is a decoding means which automatically converts the code into the proper CDTL programming information and activates the VCR to record a given television program with the corresponding channel, date, time and length. Generally multiple codes can be entered at one time for multiple program selections. The code can be printed in a television program guide in advance and selected for use with a VCR or remote controller with the decoding means.

Another principal object of the invention is to embed the decoding means into a television. The television would then at the appropriate time distribute the proper commands to a VCR and a cable box to record the desired program. The user would use the television remote or controls on the television to enter the code that signifies the program to be recorded. The same television remote and controls on the television would also be used to perform normal television control functions, such as channel selection. When the codes are entered they are transmitted to the television and the decoder in the television, which decodes the codes into CDTL information and then the codes themselves and the CDTL information could be displayed "on screen" so that the user can verify that the proper codes have been entered. Then at the appropriate time the television would transmit the proper commands to a VCR and a cable box, if necessary, to command the recording of the selected program. This

control function can be carried out by using an infrared link by placing infrared transmitters on the television cabinet, preferably at the corners. The television circuitry would include the capability of storing or learning the infrared code protocols for the VCR and the cable box.

Another principal object of the invention is to embed the decoding means into various equipments associated with television, such as a video cassette recorder, cable box or satellite receiver. In any system the decoding means would only have to be present in one of the equipments, such as the cable box, which would then at the appropriate time distribute the proper commands to the other equipments such as a VCR and a satellite receiver to record the desired program. The user would use the television remote or controls on the equipment with the decoder to enter the code that signifies the program to be recorded. The same television remote would also be used to perform normal television control functions, such as channel selection. When the codes are entered they are transmitted to the equipment with the decoder, which decodes the codes into CDTL information. Then at the appropriate time the equipment with the decoder would transmit the proper commands to a the other equipment such as a VCR, satellite receiver and a cable box to command the recording of the selected program. This control function can be carried out by using an infrared link by coupling infrared transmitters on the equipment with the decoder. The infrared transmitter can be placed in a infrared dome on the equipment, mounted behind the front panel, attached to a mouse coupled via a cable to the equipment with the decoder with the mouse placed near the receiver, or attached to a stick on miniature mouse coupled via a cable to the equipment with the decoder with the miniature mouse attached to the device with the receiver. The equipment with the decoder would include the capability of storing or learning the infrared code

protocols for the other equipment, such as a VCR, satellite receiver and a cable box.

Another embodiment of the invention includes a full function universal remote control capable of controlling various home electronic devices. The functions of the buttons of the remote control and the infrared codes needed to perform the functions are programmed remotely, such as by transmissions over telephone lines received by a microphone in the remote control.

Other objects and many of the attendant features of this invention will be more readily appreciated as the same becomes better understood by reference to the following detailed descriptions and considered in connection with the accompanying drawings in which like reference symbols designate like parts throughout the figures.

Brief Description of the Drawings

FIG. 1 is a schematic showing apparatus according to this invention with the code decoder means embedded in the video cassette recorder;

FIG. 2 is a schematic of the VCR embedded processors for command control and code decoding;

FIG. 3 is a schematic showing a preferred embodiment according to this invention with the code decoder means embedded in a remote controller;

FIG. 4 is a schematic of the processor embedded in the remote controller;

FIG. 5 is a schematic of a universal remote controller with the code decoder means embedded in the universal remote controller;

FIG. 6 is a flow graph of the G-code decoding technique;

FIG. 7 is a flow graph of the G-code encoding technique;

FIG. 8 is an illustration of part of a television calendar according to this invention;

FIG. 9 is a flow chart for decoding for cable channels;

FIG. 10 is a flow chart for encoding for cable channels;

FIG. 11. is a flow graph of the G-code decoding for cable channels including conversion from assigned cable channel number to local cable carrier channel number;

FIG. 12 is a means for decoding including a stack memory;

FIG. 13 is a flow chart for program entry into stack memory;

FIG. 14 is an operation flow chart for sending programs from remote control to main unit VCR;

FIG. 15 is a perspective view of an apparatus for using compressed codes for recorder preprogramming according to a preferred embodiment of the invention;

FIG. 16 is a front view of the apparatus of FIG. 15 showing a forward facing light emitting diode;

FIG. 17 is a perspective view of the apparatus of FIG. 15 placed in a mounting stand;

FIG. 17A is a front elevational view of the apparatus of FIG. 15 placed in the mounting stand as shown in FIG. 17;

FIG. 18 is a detail of the LCD display of the apparatus of FIG. 15;

FIG. 19 is a perspective view showing a manner of placing the apparatus of FIG. 15 relative to a cable box and a VCR;

FIG. 20 is a perspective view showing a manner of placing the mounting stand with the apparatus of FIG. 15 mounted thereon near a cable box and VCR;

FIG. 21 is a schematic showing apparatus for using compressed codes for recorder preprogramming according to a preferred embodiment of the invention;

FIG. 22 is a detailed schematic showing a preferred embodiment of apparatus implementing the schematic of FIG. 21;

FIG. 23 is a flow graph for program entry into the apparatus of FIG. 15;

FIG. 24 is a flow graph for review and program cancellation of programs entered into the apparatus of FIG. 15;

FIG. 25 is a flow graph for executing recorder preprogramming using compressed codes according to a preferred embodiment of the invention;

FIG. 26 is a flow graph for encoding program channel, date, time and length information into decimal compressed codes;

FIG. 27 is a flow graph for decoding decimal compressed codes into program channel, date, time and length information;

FIG. 28 is an embodiment of an assigned channel number/local channel number table;

FIG. 29 block diagram of a system including a television having a G-code decoder;

FIG. 30 is a schematic of a television having a G-code decoder;

FIG. 31 is a schematic showing apparatus for a G-code decoder in a television having G-code decoding;

FIG. 32 is a block diagram of a system including a television having a G-code decoder, a VCR, a cable box and a satellite receiver;

FIG. 33 is a block diagram of a system including a VCR having a G-code decoder, a television, a cable box and a satellite receiver;

FIG. 34 is a block diagram of a system including a cable box having a G-code decoder, a television, a VCR, and a satellite receiver;

FIG. 35 is a block diagram of a system including a satellite receiver having a G-code decoder, a television, a VCR, and a cable box;

FIG. 36 is a perspective view showing a cable box placed on top of a VCR having an infrared transmitter behind the front panel which communicates to the cable box infrared receiver via reflection;

FIG. 37 is a perspective view showing a cable box placed on top of a VCR having an infrared transmitter inside a infrared dome on the top of the VCR which communicates to the cable box infrared receiver;

FIG. 38 is a perspective view of a VCR having an infrared transmitter inside a mouse coupled via a cable to the VCR with the mouse placed near the cable box infrared receiver; and

FIG. 39 is a perspective view of a VCR having an infrared transmitter inside a miniature mouse coupled via a cable to the VCR with the miniature mouse stuck onto the cable box near the infrared receiver.

FIG. 40 is a perspective view of a second apparatus for using compressed codes for recorder preprogramming according to a preferred embodiment of the invention.

FIG. 41 is a bottom view of the apparatus of FIG. 41 showing a microphone hole and two electrical contact holes.

FIG. 42 shows the apparatus of FIG. 40 being used in conjunction with a telephone.

FIG. 43 is a schematic showing second apparatus for using compressed codes for recorder preprogramming according to a preferred embodiment of the invention.

FIG. 44 is an alternate schematic showing second apparatus for using compressed codes for recorder preprogramming according to a preferred embodiment of the invention.

FIG. 45 is a perspective view of an apparatus for programming remote controls with memories according to a preferred embodiment of the invention.

FIG. 46 is a perspective view of the apparatus of FIG. 45 with the hinged lid in the open position.

FIG. 47 is a rear view of the apparatus of FIG. 45 showing telephone and computer input/output ports.

FIG. 48 is a bottom view of the apparatus of FIG. 15 showing electrical contact access holes.

FIG. 49 is a perspective view of the apparatus of FIG. 45 coupled to an apparatus according to FIG. 15.

FIG. 50 is a perspective view of the apparatus of FIG. 45 coupled to an apparatus according to FIG. 40.

FIG. 51 is a schematic showing apparatus for programming remote controls with memories according to a preferred embodiment of the invention.

FIG. 52 is a schematic showing the electronic connection between apparatus for programming remote controls with memories according to a preferred embodiment of the invention and a personal computer.

FIG. 53 is a perspective view of a complete universal remote control capable of using compressed codes for recorder preprogramming according to a preferred embodiment of the invention.

FIG. 54 is a front view of the apparatus of FIG. 53.

FIG. 55 is a side view of the apparatus of FIG. 53 showing a microphone opening and an electrical contact access hole.

FIG. 56 is a rear view of the apparatus of FIG. 53.

FIG. 57 is a back view of the apparatus of FIG. 53 showing electrical contact access holes.

FIG. 58 is a block schematic of an embodiment of the apparatus of FIG. 53.

FIG. 59 is a block schematic of an alternative embodiment of the apparatus of FIG. 53.

FIG. 60 is a flow chart of the process of remotely programming the apparatus of FIG. 53 over telephone lines.

FIG. 61 shows the apparatus of FIG. 53 in its upright position, resting on a coffee table on the apparatus' rear surface.

FIG. 62 is a cross sectional view taken along line 7-7 of FIG. 53.

FIG. 63 is a cross sectional view taken along line 8-8 of FIG. 53.

FIG. 64 is a cross sectional view taken along line 9-9 of FIG. 53.

FIG. 65 is a perspective view of an alternative embodiment of the remote control of FIG. 53.

FIG. 66 is a top view of the remote control of FIG. 65.

FIG. 67 is a side view of the remote control of FIG. 65.

FIG. 68 is a front view of the remote control of FIG. 65.

FIG. 69 is a rear view of the remote control of FIG. 65.

FIG. 70 is a bottom view of the remote control of FIG. 65.

FIG. 71 is a perspective view of a second alternative embodiment of the remote control of FIG. 53.

FIG. 72 is a top view of the remote control of FIG. 71.

FIG. 73 is a side view of the remote control of FIG. 71.

FIG. 74 is a rear view of the remote control of FIG. 71.

FIG. 75 is a front view of the remote control of FIG. 71.

FIG. 76 is a bottom view of the remote control of FIG. 71.

Detailed Description

Referring now to the drawings, and more particularly, to FIG. 1, there is shown an apparatus for using encoded video recorder/player timer preprogramming information 10 according to this invention. The primary components include a remote controller 12 and a video cassette recorder/player with G-code decoder 14, which can be controlled by remote controller 12 via a command signal 16. The remote controller 12 can have a number of keys, which include numerical keys 20, G-code switch 22, function keys 24, program key 26 and power key 27. There are means in the remote controller 12 that interprets each key as it is pressed and sends the proper command signal 16 to the VCR via an infra-red light emitting diode 28. Except for the G-code switch 22 on the remote controller 12 in FIG. 1, the remote controller 12 is essentially the same as any other remote controller in function. The G-code switch 22 is provided just to allow the user to lock the remote controller 12 in the G-code mode while using a G-code, which is the name given to the compressed code which is the encoded CDTL information, to perform timer preprogramming.

A G-code consists of 1 to 7 digits, although more could be used, and is associated with a particular program. A user would look up the G-code in a program guide and just enter the G-code on the remote controller 12, instead of the present state of the art, which requires that the user enter the actual channel, date, time and length (CDTL) commands.

In order to understand the advantages of using a G-code, it is helpful to describe the best of the current state of the art, which is "on screen programming" with direct numerical entry. This technique involves about 18 keystrokes and the user has to keep switching his view back and forth between the TV screen and the remote controller while entering the CDTL information. This situation may be akin to a user having to dial an 18 digit

telephone number while reading it from a phone book. The number of keys involved and the switching back and forth of the eye tend to induce errors. A typical keying sequence for timer recording using on-screen CDTL programming is as follows:

PROG 2 1 15 07 30 2 08 00 2 04 PROG

The first program (PROG) key 26 enters the programming mode. Then a sequence of numerical keys 20 are pushed. The 2 means it is timer recording rather than time setting. The 1 means the user is now entering the settings for program 1. The 15 is the date. The 07 is starting hour. The 30 is a starting minute. The 2 means pm. The next sequence 08 00 2 is the stopping time. The 04 is channel number. Finally, the PROG is hit again to exit the program mode.

By contrast, this command could have been "coded" and entered in a typical G-code sequence as follows: PROG 1138 PROG. To distinguish that the command is a coded G-code, the G-code switch 22 should be turned to the "ON" position. Instead of having a switch, a separate key "G" can be used. The G-code programming keystroke sequence would then be: G 1138 PROG.

The use of a G-code does not preclude "on-screen" confirmation of the program information that has been entered. When the keystrokes "PROG 1138 PROG" are entered with the G-code switch in the "ON" position, the G-code would be decoded and the television could display the following message:

PROGRAM	DATE	START TIME	STOP TIME	CHANNEL
1138	15	7:30 PM	8:00 PM	4

In order for the G-code to be useful it must be decoded and apparatus for that purpose must be provided. Referring to FIG. 1, a video cassette recorder/player with

G-code decoder 14 is provided to be used in conjunction with remote controller 12. The command signal 16 sent from the remote controller 12 is sensed by the photodiode 32 and converted to electrical signals by command signal receiver 30. The electrical signals are sent to a command controller 36, which interprets the commands and determines how to respond to the commands. As shown in FIG. 1, it is also possible for the command controller 36 to receive commands from the manual controls 34 that are normally built into a VCR. If the command controller 36 determines that a G-code was received then the G-code will be sent to the G-code decoder 38 for decoding. The G-code decoder 38 converts the G-code into CDTL information, which is used by the command controller 36 to set the time/channel programming 40. Built into the VCR is a clock 42. This is normally provided in a VCR and is used to keep track of the date and time. The clock 42 is used primarily by the time/channel programming 40 and the G-code decoder 38 functions. The time/channel programming 40 function is set up with CDTL information by the command controller 36. When the proper date and time is read from clock 42, then the time/channel programming 40 function turns the record/playback 44 function "ON" to record. At the same time the tuner 46 is tuned to the proper channel in the television signal 18. Later the user can command the record/playback 44 function to a playback mode to watch the program via the television monitor 48.

An alternate way to control the recorder is to have the command controller 36 keep all the CDTL information instead of sending it to the time/channel programming 40. The command controller would also keep track of the time by periodically reading clock 42. The command controller would then send commands to the time/channel programming 40 to turn on and off the recorder and to tuner 46 to cause it to tune to the right channel at the right time according to the CDTL information.

The clock 42 is also an input to G-code decoder 38, which allows the G-code decoding to be a function of the clock, which lends a measure of security to the decoding technique and makes it harder to copy. Of course this requires that the encoding technique must also be a function of the clock.

A possible realization of the command controller 36 and the G-code decoder 38 is shown in FIG. 2. The command controller 36 function can be realized with a microprocessor 50, a random access memory 52 and a read only memory 54, which is used for program storage. The input/output 56 function is adapted to receive commands from the command signal receiver 30, the manual controls 34 and the clock 42, and to output signals to a display 35, the clock 42, and the time/channel programming 40 function. If the microprocessor 50 interprets that a G-code has been received, then the G-code is sent to microcontroller 60 for decoding. The microcontroller 60 has an embedded random access memory 62 and an embedded read only memory 64 for program and table storage. The clock 42 can be read by both microprocessor 50 and microcontroller 60.

An alternative to having microcontroller 60 perform the G-code decoding is to build the G-code decoding directly into the program stored in read only memory 54. This would eliminate the need for microcontroller 60. Of course, other hardware to perform the G-code decoding can also be used. The choice of which implementation to use is primarily an economic one.

The blocks in Figs. 1 and 2 are well known in the prior art and are present in the following patents: Fields, patent no. 4,481,412; Scholz, patent no. 4,519,003; and Brugliera, patent no. 4,631,601. For example, clock 42 is analogous to element 7 in Scholz and element 17 in Brugliera. Other analogous elements are: command signal receiver 30 and Scholz 14 and Brugliera 12; tuner 46 and Scholz 6 and Brugliera 10; time/channel

programming 40 and Scholz 8, 11 and Brugliera 16; record & playback 44 and Scholz 1, 2, 4; command controller 36 and Scholz 11, 10 and Brugliera 12; microprocessor 50 and Fields 27; RAM 52 and Fields 34; ROM 54 and Fields 33; manual controls 34 and Scholz 15, 16; and remote controller 12 and Scholz 26 and Brugliera 18.

FIG. 3 illustrates an alternate preferred embodiment of this invention. In FIG. 3 a remote controller with embedded G-code decoder 80 is provided. The remote controller with embedded G-code decoder 80 is very similar to remote controller 12, except for the addition of the G-code decoder 82. Note that it is also possible in any remote controller to provide a display 84. The remote controller with embedded G-code decoder 80 would be used in conjunction with a normal video cassette recorder/player 70, which would not be required to have an embedded G-code decoder. The numerals for the subelements of video cassette recorder/player 70 are the same as described above for the video cassette recorder/player with G-code decoder 14 and have the same function, except for the absence of G-code decoder 38. This preferred embodiment has the advantage that it can be used in conjunction with VCRs that are presently being used. These do not have a G-code decoding capability. Replacing their remote controllers with ones that have this capability built-in can vastly improve the capability to do timer preprogramming for a modest cost.

FIG. 4 illustrates a possible realization of the G-code decoder 82 built into the remote controller with embedded G-code decoder 80. A microcontroller 60 can be used as before to decode the G-code, as well as interface with the display 84, a clock 85, the keypad 88 and the light emitting diode 28. Alternately, other hardware implementations can be used to perform the G-code decoding. The clock 85 is provided in the remote controller 80 so that the G-code decoder 82 can be made to have the clock 85 as one of its inputs. This allows the

G-code decoding to be a function of the clock 85, which lends a measure of security to the decoding technique and makes it harder to copy.

The remote controller with embedded G-code decoder as described above would send channel, date, time and length information to the video cassette recorder/player 70, which would use the CDTL information for tuning into the correct channel and starting and stopping the recording function. The remote controller may have to be unique for each different video cassette recorder/player, because each brand or model may have different infrared pulses for each type of information sent such as the channel number keys and start record and stop record keys. The particular infrared pulses used for each key type can be called the vocabulary of the particular remote controller. Each model may also have a different protocol or order of keys that need to be pushed to accomplish a function such as timer preprogramming. The protocol or order of keys to accomplish a function can be called sentence structure. If there is a unique remote controller built for each model type, then the proper vocabulary and sentence structure can be built directly into the remote controller.

An alternate to having the remote controller with embedded G-code decoder send channel, date, time and length information to the video cassette recorder/player 70, is to have the remote controller with embedded G-code decoder perform more operations to simplify the interfacing problem with existing video cassette recorder/players. In particular, if the remote controller not only performs the G-code decoding to CDTL, but also keeps track of time via clock 85, then it is possible for the remote controller to send just channel, start record and stop commands to the video cassette recorder/player. The channel, start and stop are usually basic one or two key commands, which means there is no complicated protocol or sentence structure involved.

Thus, to communicate with a diverse set of video cassette recorder/player models it is only necessary to have memory within the remote controller, such as ROM 64 of FIG. 4, for storing the protocol for all the models or at least a large subset. The G-code would be entered on the remote controller as before and decoded into channel, date, time and length information, which would be stored in the remote controller. Via clock 85, the time would be checked and when the correct time arrives the remote controller would automatically send out commands to the VCR unit for tuning to the correct channel and for starting and stopping the recording. It is estimated that only two (2) bytes per key for about 15 keys need to be stored for the vocabulary for each video cassette recorder/player model. Thus, to cover 50 models would only require about 30*50 = 1500 bytes of memory in the remote controller. It would be necessary to position the remote controller properly with respect to the VCR unit so that the infrared signals sent by the remote controller are received by the unit.

Another preferred embodiment is to provide a universal remote controller 90 with an embedded G-code decoder. Universal remote controllers provide the capability to mimic a number of different remote controllers. This reduces the number of remote controllers that a user needs to have. This is accomplished by having a learn function key 94 function on the universal remote controller, as shown in FIG. 5. If the learn function key 94 is pushed in conjunction with another key, the unit will enter into the learn mode. Incoming infra-red (IR) pulses from the remote controller to be learned are detected by the infra-red photodiode 96, filtered and wave-shaped into recognizable bit patterns before being recorded by a microcontroller into a battery-backed static RAM as the particular IR pulse pattern for that particular key. This is done for all the individual keys.

An example of more complex learning is the following. If the learn function key 94 in conjunction with the program key 26 are pushed when the G-code switch is "ON", the unit will recognize that it is about to record the keying sequence of a predetermined specific example of timer preprogramming of the particular VCR involved. The user will then enter the keying sequence from which the universal remote controller 90 can then deduce and record the protocol of the timer preprogramming sequence. This is necessary because different VCRs may have different timer preprogramming command formats.

If keys are pushed without the learn function key 94 involved, the microcontroller should recognize it is now in the execute mode. If the key is one of the direct command keys, the microcontroller will read back from its static RAM the stored pulse sequence and send out command words through the output parallel I/O to pulse the output light emitting diode 28. If the key is the PROG key and the G-code switch is "OFF", then the microcontroller should recognize the following keys up to the next PROG key as a timer preprogramming CDTL command and send it out through the light emitting diode 28. If the G-code switch 22 is set to "ON" and the program key 26 is pushed, the microcontroller should recognize the following keys up to the next PROG key as a G-code command for timer preprogramming. It will decode the G-code into channel, date, start time and length (CDTL) and the microcontroller will then look up in it's static RAM "dictionary" the associated infra-red pulse patterns and concatenate them together before sending them off through the output parallel I/O to pulse the light emitting diode 28 to send the whole message in one continuous stream to the VCR.

FIG. 4 illustrates a possible realization of the G-code decoder 92 that could be built into the universal remote controller with embedded G-code decoder 90. A microcontroller 60 can be used as before to decode the G-code, as well as for interfacing with the input/output

functions including the photodiode 96. Alternately, the G-code decoding can be performed with other hardware implementations.

The universal remote controller can also be used in another manner to simplify the interfacing problem with existing video cassette recorder/players. In particular, if the universal remote controller performs not only the G-code decoding to CDTL, but also keeps track of time via clock 85 in FIG. 4, then it is possible for the universal remote controller to send just channel, start record and stop commands to the video cassette recorder/player, which as explained before, are usually basic one key commands, which means there is no complicated protocol or sentence structure involved. Thus, to communicate with a diverse set of video cassette recorder/player models it is only necessary for the universal remote controller to "learn" each key of the remote controller it is replacing. The G-code would be entered on the universal remote controller as before and decoded into channel, date, time and length information, which would be stored in the universal remote controller. Via clock 85, the time would be checked and when the correct time arrives the universal remote controller would automatically send out commands to the VCR unit for tuning to the correct channel and for starting and stopping the recording. It would be necessary to position the universal remote controller properly with respect to the VCR unit so that the signals sent by the universal remote are received by the VCR unit.

There are a number of ways that the G-code decoding can be performed. The most obvious way is to just have a large look up table. The G-code would be the index. Unfortunately, this would be very inefficient and result in a very expensive decoder due to the memory involved. The total storage involved is a function of the number of total combinations. If we allow for 128 channels, 31 days in a month, 48 on the hour and on the half hour start times in a twenty four hour day, and 16 length selections

in half hour increments, then the total number of combinations is 128x31x48x16 = 3,047,424. This number of combinations can be represented by a 7 digit number. The address to the table would be the 7 digit number. In the worst case, this requires a look up table that has about 4,000,000 rows by 15 to 16 digital columns, depending on the particular protocol. These digital columns would correspond to the CDTL information required for "on screen programming". Each digit could be represented by a 4 bit binary number. Thus, the total storage number of bits required for the look up table would be about 4,000,000x16x4 = 256,000,000. The present state of the art has about 1 million bits per chip. Thus, G-code decoding using a straightforward table look up would require a prohibitively expensive number of chips.

Fortunately, there are much more clever ways of performing the G-code decoding. FIG. 6 is a flow diagram of a preferred G-code decoding technique. To understand G-code decoding, it is easiest to first explain the G-code encoding technique, for which FIG. 7 is the flow chart. Then the G-code decoding technique, which is the reverse of the G-code encoding will be explained.

The encoding of the G-codes can be done on any computer and is done prior to preparation of any program guide that would include G-codes. For each program that will be printed in the guide, a channel, date, time and length (CDTL) code 144 is entered in step 142. Step 146 separately reads the priority for the channel, date, time and length in the priority vector storage 122, which can be stored in read only memory 64. The priority vector storage 122 contains four tables: a priority vector C table 124, a priority vector D table 126, a priority vector T table 128 and a priority vector L table 130.

The channel priority table is ordered so that the most frequently used channels have a low priority number.

An example of the data that is in priority vector C table 124 follows.

channel	4	7	2	3	5	6	11	13	...
priority	0	1	2	3	4	5	6	7	...

Generally the dates of a month all have an equal priority, so the low number days in a month and the low number priorities would correspond in the priority vector D table as in the following example.

date	1	2	3	4	5	6	7	8	...
priority	0	1	2	3	4	5	6	7	...

The priority of the start times would be arranged so that prime time would have a low priority number and programs in the dead of the night would have a high priority number. For example, the priority vector T table would contain:

time	6:30pm	7:00pm	8:00pm	7:30pm	...
priority	0	1	2	3	...

An example of the data that is in the priority vector L table 130 is the following:

length of program (hours)	0.5	1.0	2.0	1.5	3.0	...
priority	0	1	2	3	4	...

Suppose the channel date time length (CDTL) 144 data is 5 10 19.00 1.5, which means channel 5, 10th day of the month, 7:00 PM, and 1.5 hours in length, then for the above example the C_p, D_p, T_p, L_p data 148, which are the result of looking up the priorities for channel, date, time and length in priority tables 124, 126, 128 and 130 of FIG. 7, would be 4 9 1 3. Step 150 converts C_p, D_p, T_p, L_p data to binary numbers. The number of binary bits in each

conversion is determined by the number of combinations involved. Seven bits for C_p, which can be denoted as C_7 C_6 C_5 C_4 C_3 C_2 C_1, would provide for 128 channels. Five bits for D_p, which can be denoted as D_5 D_4 D_3 D_2 D_1, would provide for 31 days in a month. Six bits for T_p, which can be denoted as T_6 T_5 T_4 T_3 T_2 T_1, would provide for 48 start times on each half hour of a twenty four hour day. Four bits for length, which can be denoted as L_4 L_3 L_2 L_1, would provide for a program length of up to 8 hours in half hour steps. Together there are 7+5+6+4 = 22 bits of information, which correspond to 2**22 = 4,194,304 combinations.

The next step is to use bit hierarchy key 120, which can be stored in read only memory 64 to reorder the 22 bits. The bit hierarchy key 120 can be any ordering of the 22 bits. For example, the bit hierarchy key might be:

L_4	C_3	...	T_2	C_2	T_1	C_1	L_1	D_5	D_4	D_3	D_2	D_1
22	21	...	10	9	8	7	6	5	4	3	2	1

Ideally the bit hierarchy key is ordered so that programs most likely to be the subject of timer preprogramming would have a low value binary number, which would eliminate keystrokes for timer preprogramming the most popular programs. Since all the date information has equal priority, then the D_5 D_4 D_3 D_2 D_1 bits are first. Next T_1 C_1 L_1 are used, because for whatever date it is necessary to have a time channel and length and T_1 C_1 L_1 are the most probable in each case due to the ordering of the priority vectors in priority vector storage 122. The next bit in the hierarchy key is determined by the differential probabilities of the various combinations. One must know the probabilities of all the channels, times and lengths for this calculation to be performed.

For example, the probability for channels may be:

channel	4	7	2	3	5	6	11	13	...
priority	0	1	2	3	4	5	6	7	...
probability(%)	5	4.3	4	3	2.9	2.1	2	1.8	...

The probabilities for times might be:

time	6:30pm	7:00pm	8:00pm	7:30pm	...
priority	0	1	2	3	...
probability(%)	8	7.8	6	5	...

And, the probabilities for lengths might be:

length of program (hours)	0.5	1.0	2.0	1.5	3.0	...
priority	0	1	2	3	4	...
probability(%)	50	20	15	5	4	...

The probabilities associated with each channel, time and length, as illustrated above, are used to determine the proper ordering. Since the priority vector tables are already ordered by the most popular channel, time, and length, the order in which to select between the various binary bits for one table, for example selecting between the C_7 C_6 C_5 C_4 C_3 C_2 C_1 bits, is already known. The C_1 bit would be selected first because as the lowest order binary bit it would select between the first two entries in the channel priority table. Then the C_2 bit would be selected and so on. Similarly, the T_1 and L_1 bits would be used before any of the other time and length bits. A combination of the C_1, T_1, L_1 and D_5 D_4 D_3 D_2 D_1 bits should be used first, so that all the information is available for a channel, date, time and length. The D_5 D_4 D_3 D_2 D_1 bits are all used because the date bits all have equal priority and all are needed to specify a date even if some of the bits are binary zero.

At this point the bit hierarchy key could be:

$$T_1\ C_1\ L_1\ D_5\ D_4\ D_3\ D_2\ D_1$$

The first channel binary bit C_1 by itself can only select between $2^1 = 2$ channels, and the first two channels have a probability percent of 5 and 4.3, respectively. So the differential probability of C_1 is 9.3. Similarly, the differential probability of T_1 is 8 + 7.8 = 15.8, and the differential probability of L_1 is 50 + 20 = 70. If the rules for ordering the bit hierarchy key are strictly followed, then the first 8 bits of the bit hierarchy key should be ordered as:

$$C_1\ T_1\ L_1\ D_5\ D_4\ D_3\ D_2\ D_1,$$

because L_1 has the highest differential priority so it should be next most significant bit after D_5, followed by T_1 as the next most significant bit, and then C_1 as the next most significant bit. Notice that the bit hierarchy key starts with the least significant bit D_1, and then is filled in with the highest differential probability bits. This is for the purpose of constructing the most compact codes for popular programs.

The question at this point in the encoding process is what should the next most significant bit in the hierarchy key be: T_2, C_2, or L_2. This is again determined by the differential probabilities, which can be calculated from the above tables for each bit. Since we are dealing with binary bits, the C_2 in combination with C_1 selects between $2^2 = 4$ channels or 2 more channels over C_1 alone. The differential probability for C_2 is then the additional probabilities of these two additional channels and for the example this is: 4 + 3 = 7. In a similar manner C_3 in combination with C_1 and C_2 selects between $2^3 = 8$ channels or $4 = 2^{(3-1)}$ more channels over the combination of C_1 and C_2.

So the differential probability of C_3 is the additional probabilities of these four additional channels and for the example this is: 2.9 + 2.1 + 2 + 1.8 = 8.8. In a similar manner, the differential probabilities of T_2 and L_2 can be calculated to be 6 + 5 = 11 and 15 + 5 = 20, respectively. Once all the differential probabilities are calculated, the next step is determining which combinations of bits are more probable.

Now for the above example, which combination is more probable: T_2 with C_1 L_1, or C_2 with T_1 L_1, or L_2 with T_1 C_1. This will determine the next bit in the key. So, which is greater: 11x9.3x70= 7161; 7x15.8x70= 7742; or 20x15.8x9.3= 2938.8? In this case the combination with the greatest probability is 7x15.8x70= 7742, which corresponds to C_2 with T_1 L_1. So, C_2 is selected as the next bit in the bit hierarchy key.

The next bit is selected in the same way. Which combination is more probable: C_3 with T_1 L_1, or T_2 with C_1 or C_2 and L_1, or L_2 with C_1 or C_2 and T_1. For the example shown, which has the greatest probability: 8.8x15.8x70= 9732.8; 11x(9.3+7)x70= 12551; or 20x(9.3+7)x15.8= 5150.8? In this case the combination with the greatest probability is 11x(9.3+7)x70= 12551, which corresponds T_2 with C_1 or C_2 and L_1. So, T_2 is selected as the next bit in the bit hierarchy key. This procedure is repeated for all the differential probabilities until the entire key is found.

Alternately, the bit hierarchy key can be just some arbitrary sequence of the bits. It is also possible to make the priority vectors interdependent, such as making the length priority vector dependent on different groups of channels. Another technique is to make the bit hierarchy key 120 and the priority vector tables 122, a function of clock 42, as shown in FIG. 7. This makes it very difficult for the key and therefore the coding technique to be duplicated or copied.

For example it is possible to scramble the date bits in the bit hierarchy key 120 as a function of the clock. Changing the order of the bits as a function of the clock would not change the effectiveness of the bit hierarchy key in reducing the number of binary bits for the most popular programs, because the date bits all are of equal priority. This could be as simple as switching the D_1 and D_5 bits periodically, such as every day or week. Thus the bit hierarchy key 120 would switch between

$$\ldots \quad C_1\ T_1 L_1\ D_5\ D_4\ D_3\ D_2\ D_1 \quad \text{and}$$

$$\ldots \quad C_1\ T_1 L_1\ D_1\ D_4\ D_3\ D_2\ D_5.$$

Clearly other permutations of the bit hierarchy key as a function of the clock are possible.

The priority vector tables could also be scrambled as a function of the clock. For example, the first two channels in the priority channel table could just be swapped periodically. If this technique is followed, then the C_p of 148 in FIG. 7 would change as a function of the clock 42. For example,

channel	4	7	2	3	5	6	11	13	...
priority	0	1	2	3	4	5	6	7	...

would change periodically to:

channel	7	4	2	3	5	6	11	13	...
priority	0	1	2	3	4	5	6	7	...

This would be a fairly subtle security technique, because a decoder that was otherwise correct would only fail if those first two channels were being used. Other clock dependencies are also possible to provide security for the coding technique.

However it is derived, the bit hierarchy key 120 is determined and stored. In step 154 the binary bits of C_p, D_p, T_p, L_p are rearranged according to the bit hierarchy key 120 to create one 22 bit binary number. Then the resulting 22 bit binary number is converted to decimal in the convert binary number to decimal G-code step 156. The result is G-code 158.

If the priority vector and the bit hierarchy key are well matched to the viewing habits of the general population, then it is expected that the more popular programs would require no more than 3 or 4 digits for the G-code.

Now that the encoding technique has been explained the decoding technique is just reversing the coding technique. This is done according to the flow chart of FIG. 6. This is the preferred G-code decoding that can be built into G-code decoder 38 in VCR 14 or the remote controller G-code decoders 82 and 92 in FIGs. 3 and 5.

The first step 102 is to enter G-code 104. Next the G-code 104 is converted to a 22 bit binary number in step 106. Then the bits are reordered in step 108 according to the bit hierarchy key 120 to obtain the reordered bits 110. Then the bits are grouped together and converted to decimal form in step 112. As this point we obtain C_p, D_p, T_p, L_p data 114, which are the indices to the priority vector tables. For the above example, we would have at this step the vector 4 9 1 3. This C_p, D_p, T_p, L_p data 114 is then used in step 116 to look up channel, date, time, and length in priority vector storage 122. The CDTL 118 for the example above is 5 10 19.00 1.5, which means channel 5, 10th day of the month, 7:00 PM, and 1.5 hours in length.

If the coding technique is a function of the clock then it is also necessary to make the decoding technique a function of the clock. It is possible to make the bit hierarchy key 120 and the priority vector tables 122, a

function of clock 42, as shown in FIG. 6. This again makes it very difficult for the key and therefore the coding technique to be duplicated or copied. It is also possible to have the decoding and encoding techniques dependent on any other predetermined or preprogrammable algorithm.

Although the above G-code encoding and decoding technique is a preferred embodiment, it should be understood that there are many ways to perform the intent of the invention which is to reduce the number of keystrokes required for timer preprogramming. To accomplish this goal there are many ways to perform the G-code encoding and decoding. There are also many ways to make the encoding and decoding technique more secure besides just making the encoding and decoding a function of the clock. This security can be the result of any predetermined or preprogrammed algorithm.

It is possible in the G-code coding and decoding techniques to use mixed radix number systems instead of binary numbers. For example, suppose that there are only 35 channels, which would require 6 binary bits to be represented; however, 6 binary bits can represent 64 channels, because $2^6 = 64$. The result is that in a binary number system there are 29 unnecessary positions. This can have the effect of possibly making a particular G-code longer than it really needs to be. A mixed radix number system can avoid this result. For example, for the case of 35 channels, a mixed radix number system with the factors of 7^1 and 5^0 can represent 35 combinations without any empty space in the code. The allowed numbers for the 7^1 factor are 0, 1, 2, 3, and 4. The allowed numbers for the 5^0 factor are 0, 1, 2, 3, 4, 5, and 6. For example, digital 0 is represented in the mixed radix number system as 00. The digital number 34 is represented in the mixed radix number system as 46, because $4*7^1+6*5^0 = 34$. The major advantage of a mixed radix number system is in

prioritizing the hierarchy key. If the first 5 channels have about equal priority and the next 30 are also about equal, then the mixed radix number system allows the two tiers to be accurately represented. This is not to say that a mixed radix number system is necessarily preferable. Binary numbers are easier to represent in a computer and use of a fixed radix number system such as binary numbers allows a pyramid of prioritization to be easily represented in the hierarchy key.

Another feature that is desirable in all of the embodiments is the capability to key in the G-code once for a program and then have the resulting CDTL information used daily or weekly. Ordinarily the CDTL information is discarded once it is used. In the case of daily or weekly recording of the same program, the CDTL information is stored and used until it is cancelled. The desire to repeat the program daily or weekly can be performed by having a "WEEKLY" or "DAILY" button on the remote controller or built into the VCR manual controls. Another way is to use one key, such as the PROG key and push it multiple times within a certain period of time such as twice to specify daily or thrice to specify weekly. For example, if the G-code switch is "ON" and the G-code for the desired program is 99 then daily recording of the program can be selected by the following keystrokes:

"PROG 99 DAILY PROG"

or by:

"PROG 99 PROG PROG".

The G-code 99 would be converted to CDTL information, which would be stored and used daily in this case. The recording would begin on the date specified and continue daily after that using the same channel time and length information. A slight twist is that daily recording could be automatically suspended during the weekends, because most daily programs are different on Saturday and Sunday.

Once a daily or weekly program is set up, then it can be used indefinitely. If it is desired to cancel a

program and if there is a "CANCEL" button on the remote controller or manual control for the VCR, then one way to cancel a program (whether it is a normal CDTL, daily or weekly entry) is to key in the following:

"PROG xx CANCEL", where xx is the G-code.

Again as before there are alternate ways of accomplishing this.

If "on screen programming" is available, then the programs that have been selected for timer preprogramming could be reviewed on the screen. The daily and weekly programs would have an indication of their type. Also the G-codes could be displayed along with the corresponding CDTL information. This would make it quite easy to review the current "menu" and either add more programs or cancel programs as desired.

A television calendar 200 according to this invention is illustrated in FIG. 8. As shown, the television calendar has multiple day of year sections 202, multiple day sections 204, multiple time of day sections 206, channel identifiers 208, and descriptive program identifiers 210, including the name of the program, arranged in a manner that is common in television guide publications. Arranged in relation to each channel identifier is a compressed code indication 212 or G-code containing the channel, date, time and length information for that entry in the television calendar. FIG. 8 shows how easy it is to perform timer programming. All one needs to do is find the program one wants to watch and enter the compressed code shown in the compressed code indication. This is in contrast to having to deal with all the channel, date, time and length entries separately. At least the channel, date and time are explicitly stated in the television guide. The length is usually only available by searching the guide to find the time of day section 206 where a new program begins and then performing some arithmetic to find the length of the program. Using the compressed G-code avoids all these complications.

For cable television programs, there is an additional issue that needs to be addressed for the compressed G-code to be useful. In a normal television guide, CDTL information is available for all the normal broadcast channels in the form of numbers including the channel numbers, such as channel 4 or 7. However, for cable channels like HBO, ESPN etc., only the names of the channels are provided in most television listings. The reason for this is that in some metropolitan areas, such as Los Angeles, there may be only one (1) edition of television guide, but there may be quite a few cable carriers, each of which may assign HBO or ESPN to different cable channel numbers. In order for a compressed code such as the G-code to be applicable to the cable channels as published by a wide area television guide publication, the following approach can be used.

First, all the cable channels would be permanently assigned a unique number, which would be valid across the nation. For example, we could assign ESPN to cable channel 1, HBO as cable channel 2, SHO as cable channel 3, etc. This assignment would be published by the television guide publications.

The video cassette recorder apparatus, such as the remote controller, the VCR unit or both, could then be provided with two (2) extra modes: "set" and "cable channel". One way of providing the user interface to these modes would be to provide two (2) extra buttons: one called SET and one called CABLE CHANNEL. The buttons could be located on the video cassette recorder unit itself or located on a remote controller, as shown in FIGs 1, 3 and 5, where SET is element 168 and CABLE CHANNEL is element 170. Of course, other user interfaces are possible.

Next, the television viewer would have to go through a one-time "setting" procedure of his VCR for all the cable channels that he would likely watch. This "setting" procedure would relate each of the assigned numbers for

each cable channel to the channel number of the local cable carrier. For example, suppose that the local cable carrier uses channel 6 for ESPN, then cable channel number 1 could be assigned to ESPN, as shown in the following table.

Cable Channel Name	Assigned Cable Chan. No.	Channel Number in the local cable carrier
ESPN	1	6
HBO	2	24
SHO	3	23
.	.	.
.	.	.
.	.	.
DIS	8	25

The user could perform the "setting" procedure by pushing the buttons on his remote controller as follows:

SET 06 CABLE CHANNEL 1 PROGRAM
SET 24 CABLE CHANNEL 2 PROGRAM
SET 23 CABLE CHANNEL 3 PROGRAM
SET 25 CABLE CHANNEL 8 PROGRAM

The "setting" procedure would create a cable channel address table 162, which would be loaded into RAM 52 of command controller 36. For the above example, the cable

channel address table 162 would have the following information.

CABLE CHANNEL ADDRESS TABLE 162

1	6
2	24
3	23
.	
.	
.	
8	25

After the "setting" procedure is performed, the TV viewer can now select cable channels for viewing by the old way: eg. pushing the key pad buttons 24 will select HBO. He can also do it the new way: eg. by pushing CABLE CHANNEL 2, which will also select HBO. The advantage of the new way is that the television guide will publish [C2] next to the program description, so the viewer will just look up the assigned channel number identifier instead of having to remember that HBO is local cable channel 24. When the CABLE CHANNEL button is pushed, command controller 36 knows that it will look up the local cable channel number in cable channel address table 162 to tune the VCR to the correct channel.

For timer preprogramming and for using the compressed G-code, a way to differentiate between broadcast and cable channels is to add an eighth channel bit, which would be set to 0 for normal broadcast channels and 1 for cable channels such as HBO. This eighth channel bit could be one of the low order bits such as the third bit C_3 out of the eight channel bits, so that the number of bits to specify popular channels is minimized, whether they be normal broadcast or cable channels. For a normal broadcast channel, the 7 other bits can be decoded according to priority vector C table 124. For a cable

channel, the 7 other bits can be decoded according to a separate cable channel priority vector table 160, which could be stored in ROM 54 of microcontroller 36. The cable channel priority vector table can be set ahead of time for the entire country or at least for an area covered by a particular wide area television guide publication.

A television guide that carries the compressed code known as the G-code will now print the cable channel information as follows:

```
          6:30 pm
[C2]      HBO  xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx (4679)
          xxxxxx(program description)xxxxxxxxxx
          xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

The [C2] in front of HBO reminds the viewer that he needs only to push CABLE CHANNEL 2 to select HBO. The (4679) is the G-code indication for this particular program.

FIG. 8 shows a section of a television guide. The cable channels all have an assigned cable channel number 188 in front of the cable channel mnemonic. Other than that the cable channel information is arranged the same as the broadcast channels with a compressed G-code 212 associated with the channel.

For timer preprogramming, the viewer need only enter the number 4679 according to the unit's G-code entry procedure, eg. PROG 4679 PROG. The G-code decoder unit will decode this G-code into "cable channel 2" and will also signal the command controller 36 with a cable channel signal 164, as shown in FIGs. 1 and 2, because the extra channel bit will be "1" which distinguishes that the G-code is for a cable channel; then, since the association of "cable channel 2" with channel 24 has been established earlier in the "setting" procedure, the command controller, if it has received a cable channel signal, will immediately look up 2 in the cable channel address

table 162 to translate it to cable channel 24, which will be used as the recording channel at the appropriate time. By associating the G-code with the assigned cable channel number rather than the local cable channel number, the G-code for that program will be valid in the whole local area, which may have many different cable carriers each of which may have different local cable channel numbers.

To include the cable channel compressed G-code feature, the decoding and encoding algorithms are as shown in FIGs 9 and 10, respectively. The encoding should be explained first before the decoding. The primary change in FIG. 10 from FIG. 7 is that a cable channel priority vector table 160 has been added and is used in look up priority step 180 if a cable channel is being encoded. Also if a cable channel is being encoded then the cable channel bit is added in the correct bit position in the convert $C_pD_pT_pL_p$ to binary numbers step 182. This could be bit C_3, as discussed before. The bit hierarchy key could be determined as before to compress the number of bits in the most popular programs; however, it needs to be 23 bits long to accommodate the cable channel bit. The maximum compressed G-code length could still be 7 digits, because 2^{23}= 8,388,608.

The decoding is shown in FIG. 9 and is just the reverse of the encoding process. After step 108, test cable channel bit 174 is added and effectively tests the cable channel bit to determine if it is a "1". If so then the command controller 36 is signaled via cable channel signal 164 of FIGs. 1 and 2 that the CDTL 118 that will be sent to it from G-code decoder 38 is for a cable channel. Then the command controller knows to look up the local cable carrier channel number based on the assigned cable channel number. In step 176 of FIG. 9, the priority vector tables including the cable channel priority vector table 160 are used to look up the CDTL 118 information.

An alternate to having the command controller receive a cable channel signal 164 is for the G-code decoder to perform all of the decoding including the conversion from assigned cable channel number to local cable carrier number. This would be the case for the remote controller implementation of FIG. 3. FIG. 11 shows the implementation of the entire decode algorithm if this step is included. All that needs to be added is convert assigned channel to local cable carrier channel step 166, which performs a look up in cable channel address table 162, if the cable channel bit indicates that a cable channel is involved. Step 166 effectively replaces step 174 in FIG. 9.

Another issue that needs addressing is the number of programs that can be preprogrammed. Since the G-code greatly simplifies the process of entering programs, it is likely that the user will quickly learn and want to enter a large number of programs; however, some existing VCRs can only store up to four (4) programs, while some can store as many as eight. Thus, the user may get easily frustrated by the programming limitations of the VCR.

One approach to this problem, is to perform the compressed G-code decoding in the remote controller and provide enough memory there to store a large number of programs, eg. 20 or 40. The remote controller would have the capability of transferring periodically several of these stored programs at a time to the VCR main unit. To provide this capability, extra memory called stack memory 76 is required inside the remote unit, as shown in FIG. 12, which other than that is identical to FIG. 4. Stack memory 76 can be implemented with a random access memory, which may in fact reside in the microcontroller itself, such as RAM 62.

The stack memory 76 is where new entry, insertion & deletion of timer preprogramming information is carried out. It is also where editing takes place. The top memory locations of the stack, for example the first 4

locations, correspond exactly to the available timer preprogramming memory in the VCR main unit. Whenever the top of the stack memory is changed, the new information will be sent over to the VCR main unit to update it.

FIG. 13 shows the sequence of events when the user enters a G-code program on the keypad of the remote controller. For illustration purposes, suppose the VCR main unit can only handle four (4) programs. Suppose also that the stack memory capacity is 20 timer preprograms. Referring to the flow chart in FIG.13, when the user enters a G-code in step 230, the microcontroller 60 first decodes it into the CDTL information in step 234 and displays it on the display unit with the additional word "entered" also displayed. The microcontroller then enters the decoded program into the stack memory in step 236.

If this is the first program entered, it is placed at the top location of the stack memory. If there are already programs in the stack memory, the newly entered program will first be provisionally placed at the bottom of the stack memory. The stack memory will then be sorted into the correct temporal order in step 240, so that the earliest program in time will appear in the top location and the last program in time will be at the bottom. Notice that the nature of the temporally sorted stack memory is such that if stack memory location n is altered, then all the locations below it will be altered.

For example, suppose the stack memory has six (6) entries already temporally ordered, and a new entry is entered whose temporal ordering places it in location 3 (1 being the top location). If this entry is placed into location 3, information which was in location 3, 4, 5, 6 will be shifted to locations 4, 5, 6, and 7. Locations 1 and 2 will remain unchanged.

The microcontroller 60, after doing the temporal ordering, checks in step 242 whether the first n entries have changed from before, where for the current example n equals 4. In this case, since a new program has been

entered into location 3, what used to be in location 3 now moves to location 4. Since the VCR's main unit program menu of 4 entries should correspond exactly to location 1 through 4 of the stack memory, entries 3 and 4 on the VCR main unit must now be revised. The microcontroller therefore sends out the new entries 3 & 4 to the main unit, in step 244 of FIG. 13. If the newly entered program, after temporal ordering, gets entered into location 5, then entries 1 through 4 have not changed from before and the microcontroller will not send any message to the VCR main unit and the microcontroller will just resume monitoring the clock 85 and the keyboard 88 as per step 246. It is assumed that when the user enters the G-code in step 230, the remote controller is pointed at the VCR main unit. The other steps of FIG. 13 happen so fast that the changes are sent in step 244 while the remote controller is still being pointed at the VCR main unit. If the user decides to delete a program in step 232, the deletion is first carried out in the stack memory. If the first 4 entries are affected, the microcontroller will send the revised information over to the VCR main unit. If the first 4 entries are not affected, then again the remote controller unit will not send anything. The deletion will only change the lower part of the stack (lower meaning location 5 to 20). This new information will be sent over to the VCR main unit at the appropriate time.

In the meantime, the VCR main unit will be carrying out its timer programming function, completing its timing preprogramming entries one by one. By the time all 4 recording entries have been completed, the stack in the remote must send some new entries over to "replenish" the VCR main unit (if the stack has more than 4 entries).

The real time clock 85 in the remote controller unit is monitored by the microcontroller to determine when the programs in the main unit have been used up. Referring to the flow chart in FIG. 14, the microcontroller

periodically checks the clock and the times for the programs at the top of the stack in step 250 (say the first 4 entries), which are identical to the VCR's main unit's menu. If on one of the periodic checks, it is determined that the recording of the main unit's menu is complete, then if there are more entries in the stack, which is tested in step 252, the display unit will be set to a blinking mode or display a blinking message in step 258 to alert the user to send more programs. Next time the user picks up the remote unit, the blinking will remind him that the VCR main unit's program menu has been completed and it is time to replenish the VCR main unit with program entries stored in the remote. The user simply picks up the remote and points it towards the VCR main unit and presses "ENTER". This will "pop" the top of the stack memory in step 260, i.e. pop all the entries in the stack up by four locations. The microcontroller will then send the new "top of the stack" (i.e. top 4 entries) over to the VCR main unit in step 262. This process will repeat until the whole stack has been emptied.

Another preferred embodiment of an apparatus for using compressed codes for recorder preprogramming is the instant programmer 300 of FIG. 15. The instant programmer 300 has number keys 302, which are numbered 0 through 9, a CANCEL key 304, a REVIEW key 306, a WEEKLY key 308, a ONCE key 310 and a DAILY (M-F) key 312, which are used to program the instant programmer 300. A lid normally covers other keys, which are used to setup the instant programmer 300. When lid 314 is lifted, the following keys are revealed: SAVE key 316, ENTER key 318, CLOCK key 320, CH key 322, ADD TIME key 324, VCR key 326, CABLE key 328, and TEST key 330. Other features of instant programmer 300 shown on FIG. 15 are: liquid crystal display 350 and red warning light emitting diode 332. The front elevation view FIG. 16 of instant programmer 300 shows front infrared (IR) diode 340 mounted on the front side 338. By placing instant programmer 300 in front of

the equipment to be programmed such as video cassette recorder 370, cable box 372, and television 374, as shown in FIG. 19, the front infrared (IR) diode 340 can transmit signals to control program recording. An IR transparent cover 336 covers additional IR transmission diodes, which are explained below.

FIG. 18 shows a detail of the liquid crystal display 350. Certain text 354 is at various times visible on the display and there is an entry area 356. Time bars 352 are displayed at the bottom of the display and their function is described below.

A companion element to the instant programmer 300 is the mounting stand 360, shown in FIG. 17, which is designed to hold instant programmer 300 between left raised side 362 and right raised side 364. The instant programmer 300 is slid between left raised side 362 and right raised side 364 until coming to a stop at front alignment flange 365, which is at the front of mounting stand 360 and connected across left raised side 362 and right raised side 364, as shown in FIG. 17A. Together elements 362, 364 and 365 provide alignment for instant programmer 300 so that IR transparent cover 336 and the IR diodes 342, 344, 346 and 348, shown in FIG. 17 are properly aligned for transmission, when the instant programmer is used as shown in FIG. 20. The mounting stand 360 has an alignment flange 366, which has the purpose of aligning the back edge of mounting stand 360, which is defined as the edge along which alignment flange 366 is located, along the front side of a cable box or VCR, or similar unit as shown in FIG. 20. When aligned as shown in FIG. 20, the mounting stand 360 aligns the instant programmer 300 so that the left IR diode 342, down IR diode 344, two back IR diodes 346 and right IR diode 348, as shown in FIG. 17, are in position to transmit signals to video cassette recorder 370 and cable box 372, as necessary. If the VCR and/or cable box functions are located within the television 374 itself, then the instant

programmer 300 could be positioned to transmit to the television 374, either in the manner of FIG. 19 or by placing the mounting stand on top of the television in the manner of FIG. 20.

By using mounting stand 360, the user only need to align the mounting stand 360, and the instant programmer 300 once with the equipment to be programmed rather than having the user remember to keep the instant programmer 300 in the correct location to transmit via front infrared (IR) diode 340, as shown in FIG. 19. Current experience with various remote controllers shows that it is difficult at best to keep a remote controller in a fixed location, for example, on a coffee table. The mounting stand 360 solves this problem by locating the instant programmer 300 with the equipment to be controlled. The left IR diode 342, down IR diode 344, two back IR diodes 346 and right IR diode 348 are positioned to transmit to the left, downward, backward, and to the right. The downward transmitter assumes that mounting stand 360 will be placed on top of the unit to be programmed. The left and right transmission allows units to the left or right to be programmed. The backward transmission back IR diodes 346 are provided so that signals can bounce off walls and other objects in the room. The front IR diode 340, the left IR diode 342, the right IR diode 348 and the down IR diode 344 are implemented with 25 degree emitting angle diodes. Two back IR diodes are provided for greater energy in that direction and are implemented with 5 degree emitting angle diodes, which focus the energy and provide for greater reflection of the IR energy off of walls or objects in the room.

Most VCR's and cable boxes can be controlled by an infrared remote controller; however, different VCR's and cable boxes have different IR codes. Although there are literally hundreds of different models of VCR's and cable boxes, there are fortunately only tens of sets of IR codes. Each set may have a few tens of "words" that

represent the different keys required, e.g. "power", "record", "channel up", "channel down", "stop", "0", "1", "2" etc. For the purpose of controlling the VCR and cable box to do recording, only the following "words" are required: "0", "1", "2", "3", "4", "5", "6", "7", "8", "9", "power", "record", "stop". The IR codes for these words for all the sets are stored in the memory of the instant programmer 300, which is located in microcomputer 380 of FIGs. 21 and 22. During setup of the instant programmer 300, the user interactively inputs to the instant programmer 300 the type and model of his VCR and cable box. The correct set of IR codes will be recalled from memory during the actual control process. In the case where the user only has a VCR, the infrared (IR) codes for that particular VCR will be recalled to control the VCR. In the case where the user has a VCR and a cable box, the IR codes "power", "record", "stop" will be recalled from the set that corresponds to the VCR whereas the IR codes for "0" through "9" will be recalled from the set that corresponds to the cable box. The reason is that in this case, the cable box controls the channel switching. Hence the channel switching signals "0" through "9" must be sent to the cable box instead of the VCR.

Initially, the user performs a setup sequence. First, the user looks up the number corresponding to the model/brand of VCR to be programmed in a table, which lists the VCR brand name and a two digit code. Then with the VCR tuned to Channel 3 or Channel 4, whichever is normally used, the user turns the VCR "OFF". Then the user presses the VCR key 326. When the display shows VCR, the user presses the two-digit code looked up in the VCR model/brand table (for example 01 for RCA). The user points the instant programmer 300 at the VCR and then presses ENTER key 318. The red warning light emitting diode 332 will flash while it is sending a test signal to the VCR. If the VCR turned "ON" and changed to Channel

09, the user presses the SAVE key 316 and proceeds to the set clock step. If the VCR did not turn "ON" or turned "ON" but did not change to Channel 09 the user presses ENTER key 318 again and waits until red warning light emitting diode 332 stops flashing. The instant programmer 300 sends the next possible VCR code, while the red warning light emitting diode 332 is flashing. If the VCR turns "ON" and changed to Channel 09 the user presses SAVE key 316, otherwise the user presses ENTER key 318 again until the VCR code is found that works for the VCR. The display shows "END" if all possible VCR codes for that brand are tried. If so, the user presses VCR key 326 code 00 and then ENTER key 318 to try all possible codes, for all brands, one at a time.

Once the proper VCR code has been found and saved, the next setup step is to set the clock on instant programmer 300. First, the user presses the CLOCK key 320. When the display shows: "YR:", the user presses the year (for example 90), then presses ENTER key 318. Then the display shows "MO:", and the user presses the month (for example 07 is July), and then presses ENTER key 318. This is repeated for "DA:" date (for example 01 for the 1st), "Hr:" hour (for example 02 for 2 o'clock), "Mn:" minute (for example 05 for 5 minutes), and "AM/PM:" 1 for AM or 2 for PM. After this sequence, the display will show "SAVE" for a few seconds and then the display will show the current time and date that have been entered. It is no longer necessary for the user to set the clock on his/her VCR.

Next, if the instant programmer 300 is also to be used as a cable box controller, then the setup steps are as follows. First, the number corresponding to the model/brand of cable box (converter) to be controlled is looked up in a cable box model brand table, that lists cable box brands and corresponding two digit codes. The VCR is tuned to Channel 03 or 04 and turned "OFF". Then the cable box is tuned to Channel 02 or 03, whichever is

normal, and left "ON". Then the CABLE key 328 is pressed. When the display shows: "CA B-:" the user enters the two digit code looked up in cable box model brand table, points the instant programmer 300 at the cable box (converter) and presses ENTER key 318. The red warning light emitting diode 332 will flash while it is sending a test signal to the cable box. If the cable box changed to Channel 09: then the user presses SAVE key 316; however, if the cable box did not change to Channel 09 the user presses ENTER key 318 again and waits until red warning light emitting diode 332 stops flashing, while the next possible code is sent. This is repeated until the cable box changes to Channel 09 and when it does the user presses SAVE key 316. If the display shows "END" then the user has tried all possible cable box codes for that brand. If so, the user presses cable code 00 and then ENTER key 318 to try all possible brand's codes, one at a time.

For some people (probably because they have cable or satellite), the channels listed in their television guide or calendar are different from the channels on their television or cable. If they are different, the user proceeds as follows. First, the user presses the CH key 322. The display will look like this: "Guide CH TV CH". Then the user presses the channel printed in the television guide or calendar (for example, press 02 for channel 2), and then the user presses the channel number that the printed channel is received on through his/her local cable company. Then the user presses ENTER key 318. This is repeated for each channel listing that is on a different channel than the printed channel. When this procedure is finished the user presses SAVE key 316.

Typically the television guide or calendar in the area will have a chart indicating the channel number that has been assigned to each Cable and broadcast channel, for example: HBO, CNN, ABC, CBS, NBC, etc. This chart would correspond, for example, to the left two columns of FIG.

28. For example, suppose the television guide or calendar has assigned channel 14 to HBO but the user's cable company delivers HBO on channel 18. Since the channel numbers are different, the user needs to use the CH key 322. The user will press the CH button (the two blank spaces under the display "Guide CH" will flash). The user then presses 14. (now the two blank spaces under the display "TV CH" will flash). The user then presses 18 and then ENTER key 318. This is repeated for each channel that is different. When finished, the user presses SAVE key 316.

After the channel settings have been saved, the user may review the settings by pressing CH key 322 and then REVIEW key 306. By repeated pressing of the REVIEW key 306 each of the set channels will scroll onto the display, one at a time.

Then the user can test to make sure that the location of the instant programmer 300 is a good one. First, the user makes sure that the VCR is turned "OFF" but plugged in and makes sure that the cable box (if there is one) is left "ON". Then the user can press the TEST key 330. If there is only a VCR, then if the VCR turned "ON", changed to channel 09 and started recording, and then turned "OFF", then the VCR controller is located in a good place.

If there is also a cable box, then if the VCR turned "ON", the cable box turned to channel 09 and the VCR started recording, and then the VCR stopped and turned "OFF", then the instant programmer 300 is located in good place.

To operate the instant programmer 300, the VCR should be left OFF and the cable box ON. The user looks up in the television guide the compressed code for the program, which he/she wishes to record. The compressed code 212 is listed in the television guide, as shown in FIG. 8. The television guide/calendar that would be used with this embodiment would have the same elements as shown on FIG. 8 except that element 188 of FIG. 8 is not required. The

compressed code 212 for the program selected by the user is entered into the instant programmer 300 by using the number keys 302 and then the user selects how often to record the program. The user presses the ONCE key 310 to record the program once at the scheduled time, or the user presses the WEEKLY key 308 to record the program every week at the same scheduled time until cancelled or the user presses the DAILY (M-F) key 312 to record the program each day Monday through Friday at the same scheduled time until cancelled. This is most useful for programs such as soapbox operas that air daily, but not on the weekend. To confirm the entry, the instant programmer 300 will immediately decode the compressed code and display the date, channel and start time of the program entered by the user. The length of the entered program is also displayed by time bars 352 that run across the bottom of the display. Each bar represents one hour (or less) of program.

Then the user just needs to leave the instant programmer 300 near the VCR and cable box so that commands can be transmitted, and at the right time, the instant programmer 300 will turn "ON" the VCR, change to the correct channel and record the program and then turn the VCR "OFF". The user must just make sure to insert a blank tape.

The REVIEW key 306 allows the user to step through the entered programs. These are displayed in chronological order, by date and time. Each time the REVIEW key 306 is pressed, the next program is displayed, until "END" is displayed, when all the entered programs have been displayed. If the REVIEW key 306 is pressed again the display will return to the current date and time.

If the user wishes to cancel a program, then the user presses REVIEW key 306 until the program to cancel is displayed, then the user presses CANCEL key 304. The display will say "CANCELLED". Also, any time the user

presses a wrong number, pressing the CANCEL key 304 will allow the user to start over.

Certain television programs, such as live sports, may run over the scheduled time slot. To ensure that the entire program is recorded, the user may press the ADD TIME key 324 to increase the recording length, even while the program is being recorded. The user presses the REVIEW key 306 to display the program, then presses ADD TIME key 324. Each time ADD TIME key 324 is pressed, 15 minutes is added to the recording length.

When the current time and date is displayed, the amount of blank tape needed for the next 24 hours is also displayed by the time bars 352 that run across the bottom of the display. Each bar represents one hour (or less) of tape. The user should check this before leaving the VCR unattended to ensure that there is enough blank tape.

Each time a program code is entered, the instant programmer 300 automatically checks through all the entries to ensure that there is no overlap in time between the program entries. If the user attempts to enter a program that overlaps in time with a program previously entered, then the message "CLASH" appears. Then, as summarized by step 432 of FIG. 23, the user has the following options: 1) if the user wishes to leave the program previously entered and forget about the new one, the user does nothing and after a short time delay, the display will return to show the current time and date; 2) if the user wishes the program which starts first to be recorded to its end, and then to record the remainder of the second program, then the user presses ONCE key 310, DAILY (M-F) key 312, or WEEKLY key 308 again (whichever one the user pushed to enter the code). If the programs have the same starting time, then the program most recently entered will be recorded first. If on being notified of the "CLASH", the user decides the new program is more important than the previously entered program,

then the user can cancel the previously entered program and then re-enter the new one.

In some locations, such as in some parts of Colorado, the cable system airs some channels three (3) hours later/earlier than the times listed in the local television guide. This is due to time differences depending on whether the channel is received on a east or west satellite feed. For the user to record the program 3 hours later than the time listed in the television guide the procedure is as follows. First the user enters the code for the program and then presses SAVE key 316 (for +) and then presses ONCE key 310, DAILY (M-F) key 312, or WEEKLY key 308, as desired. For the user to record the program 3 hours earlier than the time listed in the television guide the procedure is as follows. First the user enters the code for the program and then presses ENTER key 318 (for -) and then presses ONCE key 310, DAILY (M-F) key 312, or WEEKLY key 308, as desired. The instant programmer 300 will display the time that the program will be recorded, not the time shown in the television guide.

There are certain display messages to make the instant programmer 300 more user friendly. The display "LO BATT" indicates that the batteries need replacement. "Err: ENTRY" indicates an invalid entry during set up. "Err: CODE" indicates that the program code number entered is not a valid number. If this is displayed the user should check the television guide and reenter the number. "Err: DATE" indicates the user may have: tried to select a daily recording (Monday to Friday) for a Saturday or Sunday program; tried to select weekly or daily recording for a show more than 7 days ahead, because the instant programmer 300 only allows the weekly or daily recording option to be used for the current weeks' programs (±7 days); or tried to enter a program that has already ended. "FULL" indicates that the stack storage of the programs to be recorded, which is implemented in random access memory (RAM) inside the instant programmer 300 has been filled.

The user could then cancel one or more programs before entering new programs. "EMPTY" indicates there are no programs entered to be recorded. The number of programs to be recorded that can be stored in the instant programmer 300 varies depending on the density of RAM available and can vary from 10 to more.

FIG. 21 is a schematic of the circuitry needed to implement the instant programmer 300. The circuity consists of microcomputer 380, oscillator 382, liquid crystal display 384, key pad 386, five way IR transmitters 390 and red warning light emitting diode 332. The microcomputer 380 consists of a CPU, ROM, RAM, I/O ports, timers, counters and clock. The ROM is used for program storage and the RAM is used among other purposes for stack storage of the programs to be recorded. The liquid crystal display 384 is display 350 of FIGs. 15 and 18. The key pad 386 implements all the previously discussed keys. The five way IR transmitters 390 consists of front infrared (IR) diode 340, left IR diode 342, down IR diode 344, two back IR diodes 346 and right IR diode 348. FIG. 22 shows the detailed schematic of the instant programmer 300 circuitry and previously identified elements are identified by the same numbers. The microcomputer can be implemented with a NEC μPD7530x part, which can interface directly with the display, the keypad, the light emitting diodes and the oscillator. The 25 degree IR diodes can be implemented with NEC 313AC parts and the 5 degree IR diodes can be implement with Litton 2871C IR diodes.

The flow charts for the program that is stored in the read only memory (ROM) of the microcomputer 380 that executes program entry, review and program cancellation, and record execution are illustrated in FIGs. 23, 24, and 25, respectively. The FIG. 23 for program entry, which process was described above, consists of the following steps: display current date, time and time bars step 402, which is the quiescent state of instant programmer 300; scan keyboard to determine if numeric decimal compressed

code entered step 404; display code as it is entered step 406; user checks if correct code entered step 408 and user presses CANCEL key 304 step 428; user advances or retards start time by three hours by pressing SAVE key 316 or ENTER key 318 step 410; user presses ONCE key 310, WEEKLY key 308 or DAILY key 312 key step 412; microcomputer decodes compressed code into CDTL step 414; test if conflict with stored programs step 416, if so, display "CLASH" message step 420, user presses ONCE key 310, WEEKLY key 308 or DAILY key 312 step 422, then accommodate conflicting entries step 432, as described above in the discussion of the "CLASH" options, and entry not saved step 424; set display as date, channel, start time and duration (time bars) for ONCE, or DA, channel, start time and duration for DAILY, or day of week, channel, start time and duration for WEEKLY step 418; user presses ADD TIME key 324, which adds 15 minutes to record time step 426; user checks display step 430; enter program on stack in chronological order step 434 wherein the stack is a portion of the RAM of microcontroller 380; and calculate length of tape required and update time bars step 436.

The FIG. 24 flowchart for review and cancellation, which process was described above, consists of the following steps: display current date, time and time bars step 402; REVIEW key 306 pressed step 442; test if stack empty step 444, display "EMPTY" step 446, and return to current date and time display step 448; display top stack entry step 450; user presses ADD TIME key 324 step 452 and update time bars step 460; user presses REVIEW key 306 step 454 and scroll stack up one entry step 462; user presses CANCEL key 304 step 456 and display "CANCELLED" and cancel program step 464; and user does nothing step 458 and wait 30 seconds step 466, wherein the 30 second timeout can be implemented in the timers of microcomputer 380.

The FIG. 25 flowchart for record execution, which is the process of automatically recording a program and which

was described above, consists of the following steps: compare start time of top program in stack memory with current time step 472; test if three minutes before start time of program step 474; start red warning LED 332 blinking for 30 seconds step 476; display channel, start time and blinking "START" message step 478, is correct start time reached step 480 and send power ON signal to VCR and display "REC" message step 482; test if a cable box is input to VCR step 484, send channel switching signals to VCR step 486 and send channel switching signals to cable box step 488; send record signals to VCR step 490; compare stop time with current time step 492, test if stop time reached step 494 and display "END" message step 496; send stop signals to VCR step 498; send power OFF signal to VCR step 500; and pop program stack step 502.

FIG. 26 is a flowchart of the method for encoding channel, date, time and length (CDTL) into decimal compressed code 510. This process is done "off-line" and can be implemented on a general purpose computer and is done to obtain the compressed codes 212 that are included in the program guide or calendar of FIG. 8. The first step in the encoding method is the enter channel, date, time and length (CDTL) step 512 wherein for a particular program the channel, date, start time and length CDTL 514 of the program are entered. The next step is the look up assigned channel number step 516, which substitutes an assigned channel number 522 for each channel 518. Often, for example for network broadcast channels, such as channel 2, the assigned channel number is the same; however, for a cable channel such as HBO a channel number is assigned and is looked up in a cable assigned channel table 520, which would essentially be the same as the first two columns of the table of FIG. 28. Next, the look up priority of channel, date and time/length in priority vector tables step 524 performs a look up in priority vector channel (C) table 526, priority vector date (D) table 528 and priority vector time/length (TL) table 530

using the indices of channel, date and time/length, respectively, to produce the vector C_p, D_p, TL_p 532. The use of a combined time/length (TL) table to set priorities recognizes that there is a direct relationship between these combinations and the popularity of a program. For example, at 6:30 PM, a short program is more likely to be popular than a 2 hour program, because it may be the dinner hour.

The channel priority table is ordered so that the most frequently used channels have a low priority number. An example of the data that is in the priority vector C table 526 follows.

channel	4	7	2	3	5	6	11	13	...
priority	0	1	2	3	4	5	6	7	...

Generally the dates of a month all have an equal priority or equal usage, so the low number days in a month and the low number priorities would correspond in the priority vector D table 528 as in the following example.

date	1	2	3	4	5	6	7	8	...
priority	0	1	2	3	4	5	6	7	...

The priority of the start times and length of the programs could be arranged in a matrix that would assign a priority to each combination of start times and program lengths so that more popular combinations of start time and length would have a low priority number and less popular combinations would have a high priority number.

For example, a partial priority vector T/L table 530 might appear as follows.

Priority TL Table

TIME	6:30pm	7:00pm	7:30pm	8:00pm	...
Length (hrs)					
.5	8	4	7	10	
1.0	12	15	13	18	
1.5	20	19	17	30	

Suppose the channel, date, time and length (CDTL) 514 data is channel 5, February 10, 1990, 7:00PM and 1.5 hours in length, then the C_p,D_p,TL_p data 532 for the above example would be 4 9 19. The next step is the convert C_p, D_p, TL_p to binary numbers and concatenate them into one binary number step 534, resulting in the data word $...TL_2TL_1...C_2C_1...D_2D_1$ 536. For the example given above, converting the $...TL_2TL_1...C_2C_1...D_2D_1$ 536 word to binary would yield the three binary numbers: ...0010011, ...0100, ...01001. The number of binary bits to use in each conversion is determined by the number of combinations involved. This could vary depending on the implementation; however one preferred embodiment would use eight bits for C_p, denoted as C_8 C_7 C_6 C_5 C_4 C_3 C_2 C_1, which would provide for 256 channels, five bits for D_p, which can be denoted as D_5 D_4 D_3 D_2 D_1, would provide for 31 days in a month, and fourteen bits for TL_p, denoted as $TL_{14}...$ TL_3 TL_2 TL_1, which would provide for start times spaced every 5 minutes over 24 hours and program lengths in increments of 5 minute lengths for programs up to 3 hours in length and program length in increments of 15 minute lengths for programs from 3 to 8 hours in length. This requires about 288*(36+20)= 16,128 combinations, which are provided by the 2**14= 16,384 binary combinations. Altogether there are 8+5+14 = 27 bits of information $TL_{14}...TL_2TL_1C_8...C_2C_1D_5...D_2D_1$. For the above example padding each number with zeros and then concatenating them would

yield the 27 bit binary number: 000000000100110000010001001.

The next step is to use bit hierarchy key 540, which can be stored in read only memory 64 to perform the reorder bits of binary number according to bit hierarchy key step 538. As described previously, a bit hierarchy key 540 can be any ordering of the $\ldots TL_2TL_1\ldots C_2C_1\ldots D_2D_1$ 536 bits and in general will be selected so that programs most likely to be the subject of timer preprogramming would have a low value compressed code 212, which would minimize keystrokes. The ordering of the bit hierarchy key can be determined by the differential probabilities of the various bit combinations as previously discussed. The details of deriving a bit hierarchy key 540 were described relative to bit hierarchy key 120 and the same method can be used for bit hierarchy key 540. For example, the bit hierarchy key might be:

TL_3	C_3	...	TL_{10}	C_2	TL_1	C_1	L_1	D_5	D_4	D_3	D_2	D_1
27	26	...	10	9	8	7	6	5	4	3	2	1

The next step is the combine groups of bits and convert each group into decimal numbers and concatenate into one decimal number step 542. For example, after reordering according to the bit hierarchy key, the code may be 000000001010010000010001001, which could be grouped as 00000000101001000,0010001001. If these groups of binary bits are converted to decimal as 328,137 and concatenated into one decimal number, then the resulting decimal number is 328137. The last encoding step is the permute decimal number step 546, which permutes the decimal number according to permutation function 544 that is dependent on the date 548 and in particular the month and year and provides a security feature for the codes. After the permute decimal number step 546, the decimal compressed code $G_6\ldots G_2G_1$ 550 may, for example, be 238731.

These encoded codes are then included in a program guide or calendar as in the compressed code indication 212 of FIG. 8.

FIG. 27 is a flowchart of the method for decoding a decimal compressed code into channel, date, time and length 560, which is step 414 of FIG. 23. Once the decimal compressed code $G_8 \ldots G_2 G_1$ 564 is entered in step 562, it is necessary to invert the permutation function of steps 544 and 546 of FIG. 26. The first step is the extract day code step 566, which extracts the day code for the program in the decimal compressed code and passes the day code to step 568, which also receives the current day 574 from the clock 576, which is implemented by microcomputer 380 in FIGs. 21 and 22. The clock 576 also sends the current month and year to the permutation function 570, which is dependent on the month and year. Then step 568 performs the function: if day code is same or greater than current day from clock, then use permutation function for month/year on clock, otherwise use permutation function for next month after the month on the clock and use next year if the month on the clock is December. In other words, since there is provision for preprogramming recording for one month or 31 days ahead, if the day for the program is equal to or greater than the current day of the month, then it refers to a day in the present month; otherwise, if the day for the program is less than the current day of the month, it must refer to a program in the next month. The extract day code step 566, which must be performed before the invert permutation of decimal compressed code step 580, is accomplished by a prior knowledge of how the permute decimal number step 546 of FIG. 26 is performed relative to the day code information.

The selected permutation method 578 is used in the invert permutation of decimal compressed code step 580. For the example given above, the output of step 580 would

be: 328137. The next step is the convert groups of decimal numbers into groups of binary numbers and concatenate binary groups into one binary number step 584, which is the inverse of step 542 of FIG. 26 and for the above example would result in the binary code: 00000000101001000010001001. Then the bit hierarchy key 588 is used in the reorder bits of binary number according to bit hierarchy key step 586, which inverts step 538 of FIG. 26 to obtain 00000000010011000010001001 for the above example, which is $...TL_2TL_1...C_2C_1...D_2D_1$ 582 corresponding to 536 of FIG. 26. The next step is to group bits to form three binary numbers TL_b, C_b, D_b and convert to decimal numbers step 590 resulting in C_p, D_p, TL_p 592, which for the example above would be: 4, 9, 19, and which are priority vectors for channel, day and time/length, which in turn are used to look up channel, day, time and length 604 in priority vector channel (C) table 598, priority vector date (D) table 600, and priority vector time/length (TL) table 602, respectively.

The look up local channel number step 606 looks up the local channel 612 given the assigned channel number 608, in the assigned/local channel table 610, which is setup by the user via the CH key 322, as explained above. An example of the assigned/local channel table 610 is the right two columns of the assigned/local channel table 620 of FIG. 28. The correspondence between the assigned channel numbers, such as 624 and 628, and the local channel numbers, such as 626 and 630 is established during setup by the user. For the example, FIG. 28 shows an exact correspondence between the assigned channel number 5 and the local channel number 5. The last step is the append month and year to day to form date step 614. The correct month and year are obtained from step 568 and are again dependent on whether the day code is equal to or greater than the day from the clock or less than the day from the clock. If the day code is equal to or greater

than the day from the clock, the month and year as shown on the clock are used, otherwise the next month is used and the next year is used if the clock month is December. The result is the channel, date, time and length (CDTL) 618, which for the above example would be channel 5, February 10, 1990, 7:00PM and 1.5 hours in length.

Another preferred embodiment is to embed the decoding means into a television receiver with G-code decoder 950, as shown in FIG. 29, which is a block diagram of a system including a television receiver having a G-code decoder. The user would use the television remote controller 956 or controls on the television receiver to enter the code that signifies the program to be recorded. The same television remote and controls on the television would also be used to perform normal television control functions, such as channel selection. When a G-code is entered, the television remote would send the G-code to the television with G-code decoder 950 via infrared transmitter 958. An infrared receiver 960 on the television receiver 950 would receive the transmission and send the code to the G-code decoder 954, which would decode the code into CDTL and use this information along with a clock, which would also be embedded in the television receiver 950, to send the proper commands to the VCR 964 and cable box 966 at the appropriate time so that the selected program will be recorded at the proper time. The transmission from the television 950 would be via infrared transmitters 962, which can be placed at strategic points on the television cabinet, such as at the corners. The transmission is then received by the VCR 964 via infrared receiver 968 and the cable box 966 via infrared receiver 969.

FIG. 30 is a schematic of a television receiver having a G-code decoder. The television receiver with G-code decoder 950 would receive signals from the television remote controller 956 via infrared receiver 960, which would send the signals to either command controller 974 or directly to G-code decoder 954. The

command controller 974 may be present in the television receiver to control other items in the television, including "on screen" functions such as displaying the channel number when the channel is changed. The G-code decoder 954 would decode a sent G-code and using the date and time from clock 976 would send the proper commands to the VCR 964 and cable box 966 via infrared transmitters 962. The G-codes and other commands could also be sent to the command controller via manual control 975. When the G-code is decoded, then the G-code and the decoded CDTL information could be displayed "on screen" as shown in on screen display 978 on television display/monitor 952. The "on screen" display is not necessary and any format is optional.

FIG. 31 is a schematic showing apparatus for a G-code decoder in a television receiver having G-code decoding. The circuitry is very similar to that described in FIGs. 21 and 22; however, there are interfaces to an infrared receiver 960 and command controller 974 rather than LCD 384 and Key Pad 386. The key elements are microcontroller 980 and oscillator 982. The interface to command controller 974 is one preferred embodiment; another embodiment could have direct interfaces between the manual control 975, the infrared receiver 960, the television display/monitor 952 and the G-code decoder 954 without going through the intermediary command controller 974. The television circuitry would include the capability of storing or learning the infrared code protocols for the VCR and the cable box. The warning light emitting diode 984 would be mounted on the cabinet of the television to warn that recording was about to begin in order to alert the user to have the VCR ready with tape to record.

With the "on screen" display on television display/monitor 952, the operation of the television receiver with G-code decoder 950 can be essentially identical to that described in FIGs. 23, 24 and 25 for program entry, program review and program cancellation,

and execution of recorder preprogramming using compressed codes, respectively. Every that was displayed on LCD 384 would instead be displayed on the television monitor 952. The only difference would be that "on screen" would only perform step 402 (display current date, time and time bars) when the user put television remote controller 956 into a mode for G-code entry and transmission, program review or program cancellation. The method of encoding program channel, date, time and length information into decimal compressed codes of FIG. 26, the method of decoding decimal compressed codes into program channel, date, time and length information of FIG. 27, and the method of assigning channel numbers to local channel numbers as illustrated in FIG. 28 would stay the same.

Another preferred embodiment of the invention is to embed the decoding means into various equipments associated with television, such as a video cassette recorder, cable box or satellite receiver. In any system the decoding means would only have to be present in one of the equipments, such as the cable box, which would then at the appropriate time distribute the proper commands to the other equipments such as a VCR and a satellite receiver to record the desired program.

FIG. 32 is a block diagram of a system including a television having a G-code decoder 950, a VCR 964, a cable box 966 and a satellite receiver 986. This system would work identically to the system shown in FIG. 29, except that a satellite receiver is included, which could receive commands via infrared receiver 988 from infrared transmitters 962 mounted on television receiver with G-code decoder 950. The commands received by the satellite receiver could include on/off commands and channel select commands. The satellite receiver 986 could feed a television signal to VCR 964, which would record the program and/or relay it to television display/monitor 952.

FIG. 33 is a block diagram of a system including a VCR having a G-code decoder 991, a television 952, a cable box 966 and a satellite receiver 986. The user would use the television remote controller 956 or controls on the VCR 991 to enter the code that signifies the program to be recorded. When a G-code is entered, the television remote would send the G-code to VCR 991 with G-code decoder 992 via infrared transmitter 958. An infrared receiver 990 on the VCR 991 would receive the transmission and send the code to the G-code decoder 992, which would decode the code into CDTL and use this information along with a clock, which would also be embedded in the VCR 991, to send the proper commands to the cable box 966 and the satellite receiver 986 at the appropriate time so that the selected program will be recorded at the proper time. The transmission from the VCR 991 would be via infrared transmitters 994, which can be placed at strategic points on the VCR. The transmission is then received by the cable box 966 via infrared receiver 969 and the satellite receiver 986 via infrared receiver 988.

Another preferred embodiment of the transmission method and apparatus between equipments is shown in FIG. 36, which is a perspective view showing a cable box 372 placed on top of a VCR 370 having an infrared transmitter 1008 behind the front panel 1009 which communicates to the cable box infrared receiver 1010 via reflection from surrounding reflecting surfaces such as walls.

Another preferred embodiment of the transmission method and apparatus between equipments is shown in FIG. 37, which is a perspective view showing a cable box 372 placed on top of a VCR 370 having an infrared transmitter 1014 inside a infrared dome 1012 on the top of the VCR which communicates to the cable box infrared receiver 1010 via direct communication or reflection depending on placement of the infrared receiver 1010 relative to infrared dome 1012.

Another preferred embodiment of the transmission method and apparatus between equipments is shown in FIG. 38, which is a perspective view of a VCR 370 having an infrared transmitter 1022 inside a mouse 1020 coupled via a cable 1018, which is plugged via plug 1017 into receptacle 1016 on the VCR. The mouse 1020 is placed near the cable box infrared receiver 1010. This embodiment is most useful when the cable box is separated from the VCR by walls of a cabinet, for example, that would prevent either direct or reflective infrared transmission.

Another preferred embodiment of the transmission method and apparatus between equipments is shown in FIG. 39, which is a perspective view of a VCR 370 having an infrared transmitter 1026 inside a stick on miniature mouse 1024 coupled via a cable 1018, which is plugged via plug 1017 into receptacle 1016 on the VCR. The stick on miniature mouse 1024 is stuck onto the cable box very near the infrared receiver 1010. This embodiment is also most useful when the cable box is separated from the VCR by walls of a cabinet, for example, that would prevent either direct or reflective infrared transmission.

The transmission methods and apparatus of FIGs. 36, 37, 38 and 39 could also be used with the system of FIG. 32 to transmit information from television receiver with G-code decoder 950 to VCR 964, cable box 966 and satellite receiver 986.

FIG. 34 is a block diagram of a system including a cable box having a G-code decoder 997, a television 952, a VCR 964, and a satellite receiver 986. The user would use the television remote controller 956 or controls on the cable box 997 to enter the code that signifies the program to be recorded. When a G-code is entered, the television remote would send the G-code to cable box 997 with G-code decoder 998 via infrared transmitter 958. An infrared receiver 996 on the cable box 997 would receive the transmission and send the code to the G-code decoder 998, which would decode the code into CDTL and use this

information along with a clock, which would also be embedded in the cable box 997, to send the proper commands to the VCR 964 and the satellite receiver 986 at the appropriate time so that the selected program will be recorded at the proper time. The transmission from the cable box 997 would be via infrared transmitters 1000, which can be placed at strategic points on the cable box. The transmission is then received by the VCR 964 via infrared receiver 968 and the satellite receiver 986 via infrared receiver 988. The transmission methods and apparatus of FIGs. 36, 37, 38 and 39 could also be used with the system of FIG. 34 to transmit information from cable box 997 to VCR 964 and satellite receiver 986.

FIG. 35 is a block diagram of a system including a satellite receiver 1005 having a G-code decoder, a television 952, a VCR 964, and a cable box 966. The user would use the television remote controller 956 or controls on the satellite receiver 1005 to enter the code that signifies the program to be recorded. When a G-code is entered, the television remote would send the G-code to satellite receiver 1005 with G-code decoder 1004 via infrared transmitter 958. An infrared receiver 1002 on the satellite receiver 1005 would receive the transmission and send the code to the G-code decoder 1004, which would decode the code into CDTL and use this information along with a clock, which would also be embedded in the satellite receiver 1005, to send the proper commands to the VCR 964 and the cable box 966 at the appropriate time so that the selected program will be recorded at the proper time. The transmission from the satellite receiver 1005 would be via infrared transmitters 1006, which can be placed at strategic points on the satellite receiver. The transmission is then received by the VCR 964 via infrared receiver 968 and the cable box 966 via infrared receiver 969. The transmission methods and apparatus of FIGs. 36, 37, 38 and 39 could also be used with the system of FIG.

35 to transmit information from satellite receiver 1005 to VCR 964 and cable box 966.

Another preferred embodiment of an apparatus for using compressed codes for a recorder programming is the custom programmer 1100 of FIGS. 40 and 41. The custom programmer 1100 is similar to instant programmer 300 and has number keys 1102, which are numbered 0-9, a CANCEL key 1104, a REVIEW key 1106, a WEEKLY key 1108, a ONCE key 1110 and a DAILY (M-F) key 1112, which correspond directly to keys 302-312 of instant programmer 300, and which are used to program the custom programmer 1100. Like the instant programmer 300, a lid normally covers other keys, which are used to set up the instant custom programmer 1100. When lid 1114 is lifted, the following keys are revealed, but not shown in the drawings: SAVE key, ENTER key, CLOCK key, CH key, ADD TIME key, VCR key, CABLE key, and TEST key. These keys of the custom programmer 1100 correspond to and operate substantially the same as keys 316-330 of instant programmer 300, respectively. Also included in the custom programmer 1100 shown in FIG. 40 are: liquid crystal display 1134, red warning light emitting diode 1132 and IR diodes 1134, which correspond to liquid crystal display 350, red warning light emitting diode 332 and IR diodes 342-348 as shown in FIG. 15.

As discussed above, when using the instant programmer 300, the consumer initially performs a set-up sequence, consisting of selecting a protocol for the model/brand of VCR, setting the current real time, selecting a protocol for the model/brand of cable box, and entering a series of channel number assignments. Although the instant programmer 300 makes recording of television programs extremely simple, the initial set-up sequence for the instant programmer 300 is more complex and deters the use of the instant programmer by some consumers. Custom programmer 1100 includes a microphone opening 1140 through which at least one microphone inside the custom programmer 1100 can receive electronically coded audio signals that

contain the information necessary for the custom programmer's initial set-up and commands to store this information into the custom programmer 1100.

In order to receive these audio signals, a user may call a special phone number which could be a toll-free 800 number, a pay-per-minute 900 number, or a standard telephone number with standard toll charges applying. The consumer can speak to an operator who orally inquires from the consumer the information regarding the consumer's VCR model and brand, zip code, model and brand of cable box and the newspaper or other publication which the consumer will use to obtain the compressed codes. This is all the information needed to perform the initial set-up for the custom programmer 1100. From the zip code information, the operator can determine to which cable system the consumer is connected and can combine this data with the knowledge of which publication the consumer will use to select the correct local channel mapping table for the consumer.

The operator then directs the consumer to press a designated programming key which is, in the case of the preferred embodiment, the CH key located under lid 1114. When the CH key is pressed, the display 1134 with display the message "PHONE1 KEY2". Pressing the "2" numeric key places the custom programmer into the manual local channel table programming mode that is implemented by instant programmer 300 when CH key 322 is pressed. Pressing the "1" numeric key initiates the remote programming mode. The custom programmer 1100 is then ready to receive an audio signal and display 1134 displays the message "WAIT".

The operator will then direct the consumer to place the earpiece 1142 of the telephone receiver 1144 over the microphone opening 1140 of the custom programmer 1100 as generally shown in FIG. 42. The earpiece need not be placed directly against the custom programmer 1100, but may be held more than an inch away from the microphone opening with generally satisfactory results. After a pause

sufficient to allow the consumer to place the telephone receiver in the proper position, the operator will initiate the downloading of the initial set-up data and initial set-up programming commands transmitted over the telephone line 1146 using audio signals to the consumer's custom programmer 1100.

If the initial set-up data is successfully transferred to the custom programmer 1100, the display 1134 of the custom programmer 1100 will display the message "DONE". If the reception of the initial set-up data is not successful within a predetermined time limit, red warning light emitting diode 1132 will blink to inform the consumer to adjust the position of the telephone earpiece before another down load of the information is attempted. After a waiting period allowing this adjustment, the initial set-up data and commands are re-transmitted over the telephone line. If after a predetermined number of attempts to download the initial set-up information are unsuccessful, the liquid crystal display 1134 displays the message "FAIL" and the operator is again connected to the consumer allowing the operator to speak to the consumer to provide additional assistance in the positioning of the telephone earpiece.

Alternatively, a live operator could be provided by the local cable company and the initial set-up information downloaded to the custom programmer 1100 by telephone line, through the existing cable of the cable system, or any other transmission means. If local cable companies supply the live operators, the only information they would need to gather from the consumer would be the VCR brand and model and the publication containing compressed codes that the consumer plans on using, because the local cable company would know the model and brand of cable box installed at the consumer's location and the necessary data regarding the local channel designations for that cable system.

FIGS. 43 and 44 are schematics of the circuitry needed to implement alternative embodiments of the custom programmer 1100. The circuit consists of microcomputer 1150, oscillator 1152, liquid crystal display 1154, keypad 1156, five way IR transmitters 1158 and red warning light emitting diode 1160. These components directly correspond to microcomputer 380, oscillator 382, liquid crystal display 384, keypad 386, five way IR transmitters 388 and red warning light emitting diode 332, respectively of instant programmer 300 and perform in the same manner. In both FIGS. 43 and 44, earpiece 1142 generates serial audio signals which are received by microphone 1162.

As shown in FIG. 43 the audio signals received by microphone 1162 are passed through amplifier 1164 and forwarded through a DTMF decoder circuit and into a serial port of microcomputer 1150. In the alternative circuit shown in FIG. 44, the audio signals received by microphone 1162 are passed through amplifier 1166, through a high pass filter 1166 with a cutoff at approximately 1 - 5 kHz, and through a second amplifier 1170 to a serial port of microcomputer 1150.

Alternatively, a dual microphone system (not shown) may be employed to increase reliability, especially when the custom programmer 1100 is to be programmed in an environment with a high level of background noise that could interfere with the transmission of data through the single microphone acoustic means. In this system, one microphone would be placed near the telephone earpiece and the second microphone would be place some distance away from the earpiece in order to pick up background noise. A audio signal cancellation circuit is then used to effectively "subtract" the background noise picked up by the second microphone from the audio data signals combined with the background noise that is picked up from the first microphone resulting in solely clean audio data signals.

Another preferred embodiment includes a separate initial set-up programmer 1200 as shown in FIGS. 45. The

initial set-up programmer 1200 serves the same basic function as the telephonic audio signal programming capability of custom programmer 1100, namely allowing the total set up of the instant programmer 300 or custom programmer 1100 with a minimum of effort on the part of the consumer. Normally, initial set-up programmers 1200 would be maintained by sellers of either the instant programmer 300 or the custom programmer 1100. The initial set-up programmer could be programmed with the local channel tables for the cable systems and the television calendars that publish G-codes in the vicinity of the seller. When a customer purchases an instant programmer 300 or custom programmer 1100, the seller can inquire where the customer lives and which television calendar the customer uses and use the initial set-up programmer 1200 to download the appropriate local channel table for that customer. Further, the initial set-up programmer 1200 can also set the clock, VCR brand and model, and cable box brand and model for the customer's instant programmer 300 or custom programmer 1100.

The initial set-up programmer 1200 includes a keyboard 1202, a display 1204, an enclosure 1206, and a lid 1208, with hinges 1209 at the top that allow the lid to open to reveal a depression 1210 for holding instant programmers 300 and custom programmers 1100 and two electrical contact pins 1212 as shown in FIG 46. The initial set-up programmer 1200 includes a modular phone jack 1230 and a serial port 1232 as shown in FIG. 47 for transferring data to and from computers, either directly or over telephone lines.

FIG. 48 shows two access holes 1213 in the bottom of the instant programmer 300 that allow access to two contact points on the to the circuit board (not shown) inside the instant programmer 300. FIG. 49 shows the initial set-up programmer 1200 with an instant programmer 300 fit into the depression 1210 with the two contact pins 1212 extending upwards through the access holes 1213 in

the bottom of the instant programmer 300. FIG. 50 shows the initial set-up programmer 1200 with a custom programmer 1100 fit into the depression 1210 with the two contact pins 1212 extending upwards through the access holes 1136 in the bottom of the instant programmer 300.

FIG. 51 is a schematic that shows circuitry included in the initial set-up programmer 1200. The initial set-up programmer includes a microcontroller (NEC μPD7530x) 1214, a liquid crystal display 1216, a keypad 1218, static random access memory (static RAM) 1220, computer port 1222 and programming pins 1224. Local channel tables can be transferred from a computer to the initial set-up programmer 1200 and stored in static RAM 1220.

FIG. 52 is a schematic showing the data transfer connection between a personal computer 1226 and initial set-up programmer 1200. Local channel table data is output from personal computer 1226 through a serial RS-232 port with +12 and -12 volt signals. The +12 and -12 volt]signals are transformed to TTL compatible 0 and 5 volt signals by level shifter 1228 which are input into microcontroller 1214. Level shifter 1228 can be either external or internal to initial set-up programmer 1200.

Alternatively, local channel table data can be transferred to the initial set-up programmer 1200 by audio signals carried over telephone lines. Further, local channel tables may be entered into the initial set-up programmer through keyboard 1202 in the same manner used to program this information into either instant programmers 300 or custom programmers 1100.

Included in keyboard 1202 are "SEND CLK", "SEND CH", "SEND CAB" and "SEND VCR", which set the clock, download the local channel table, select the protocol for the cable box brand and model and select the protocol for the VCR brand and model, respectively when they are pressed. If the information is successfully transferred to the instant programmer 300 or custom programmer 1100 connected to the initial set-up programmer 1200, display 1204 displays the

message "Tr CK", otherwise the message "Tr Err" is displayed on display 1204.

Data is transferred to instant programmer 300 and custom programmer 1100 through the two contact pins 1212. The first of these pins is the ground pin. The second pin connects with test point 392 a shown in FIG. 22. Test point 392 is connected to both an interrupt pin and one input/output (I/O) pin of microcomputer 380. The two pins are tied together with an open collector method so that both input and output can be accomplished with one pin. The two contact pins 1212 connect to the same functional pins of the microcomputer 1150 of the custom programmer 1100. Data is transferred serially through these pins at a 4800 baud rate using TTL voltage levels. The instant programmer 300 and custom programmer 1100 return a low pulse of a predetermined length to the initial set-up programmer 1200 when they have received all of transferred data.

The invention as shown in the preferred embodiments of the custom programmer 1100 and the initial set-up programmer 1200 can be readily included within televisions, video cassette recorders, cable boxes, or satellite receivers. It would not be complicated to embed either the custom programmer 1100 or the initial set-up programmer 1200 in televisions, video cassette recorders, cable boxes, and satellite receivers by adding suitable cabling or other transmission means between various video devices being used.

Another embodiment of the invention is the custom controller 1300 shown in FIGS. 53-58. The custom controller contains the same circuitry and performs the same functions as the custom programmer 1100, but also perform the functions of a complete universal remote control that can be set up automatically. The custom controller includes on its main control surface 1302 and its auxiliary control surface 1304, buttons that perform the same functions as buttons 1102-1112, 1156 of the

custom programmer, a display 1306 that performs the same functions as display 1134, 1154 and IR transmitters 1314 which perform the same functions as IR transmitters 1131, 1158. The custom controller can also be equipped with a lid (not shown) that covers hidden keys (not shown) used to set up the custom controller like lid 1114 on the custom programmer 1100 and lid 316 and keys 316-330 on the instant programmer 300. The keys under the lid could include SAVE, ENTER, CLOCK, CH, ADD TIME, VCR, CABLE and TEST keys like the instant programmer and the custom programmer.

The custom controller includes a microphone 1308, which performs the same functions as microphone 1140 of the custom programmer and is accessible through the microphone access hole 1309. Through the microphone, the custom controller is programmed with all of the set-up information needed to function as an instant or custom programmer (i.e., channel map, current time of day, model/brand of cable box and VCR). Alternatively, the custom controller can be programmed by the initial set-up programmer 1200 shown in FIGS. 45-47 and 49-51 in the identical manner described above in connection with these figures for the instant and custom programmers. Accordingly, the custom controller includes access holes 1310 through which contact can be made with the contact pins 1212 of the set-up programmer 1200.

Custom controller 1300 also includes additional buttons on its control surfaces 1302 and 1304 that can used to operate any home electronic device that can be controlled by an infrared remote control. These standard infrared remote controls work by transmitting different IR codes for each different function to be performed by the device being controlled. Each button of the custom controller triggers the transmission of an IR code that would ordinarily be transmitted by another remote control. The actual make up of these IR codes used to control the various home electronic equipment are described in more

detail in United States Patent No. 4,623,887 to Welles, II which is hereby incorporated by reference.

Most of the time, the custom controller will be used to control televisions, VCRs, cable boxes, satellite receivers and hi-fi audio equipment. It is noted that both the instant programmer 300 and the custom programmer 1100 already functioned as universal remote controllers with respect to video recorders, cable boxes, televisions and satellite receivers as they can control diverse brands and models of these devices. However, the instant and custom programmers only use their universal remote features to change or select channels on cable boxes, video recorders, televisions and satellite receivers, begin and end recording by video recorders and turning the power on any of these devices on and off. Nonetheless, the schematic of the custom controller will be the same as the schematics of the custom programmer shown in FIGS. 43 and 44 except that the custom controller includes a keypad (see 1156) with more buttons and the size requirements for the ROM and RAM in the microcomputer (see 1150) are greater than in the custom programmer. FIGS. 58 and 59 show block diagram schematics for two alternate embodiments of the custom controller. It is noted these two schematics contain the same basic components, but the utilization and minimum size of the RAMs 1324 and 1330 and ROMs 1326, 1332 are different.

The custom controller's complete universal remote feature operates as follows. Each button on the keyboard 1320, which is mounted on control surfaces 1302, 1304 of the custom controller, is hard wired with a button code or a memory address, which is generated each time the button is pressed. The microcomputer 1322 receives the code or address generated by the pressed button and, if the button generates a code, consults a look-up table to retrieve an address for the button code. This look up table, as well as the instructions that control the operation of the microprocessor are stored in ROM 1326 and 1332.

In the embodiment of FIG. 58, the microprocessor retrieves an IR code from RAM 1324 at the address derived from the pressed button. In this embodiment, the minimum size for the ROM is very small as the ROM only needs to store the button code look up table and microprocessor instructions. However, the size of the RAM needs to be large enough to store an IR code for each button on the keyboard.

In the embodiment of FIG. 59, the microprocessor consults a look-up table in RAM 1330 which contains address to ROM 1332, which contains the actual IR codes. The ROM address is retrieved from RAM at the address derived from the pressed button on keyboard 1320. The IR code is then retrieved from ROM at the address retrieved from RAM. This embodiment allows the ROM to be preprogrammed with the IR codes for a large number of home electronic devices. This increases the minimum size of the ROM substantially, but reduces the minimum size of the RAM because ROM addresses are generally shorter than IR codes.

In both the embodiments of FIG. 58 and 59, the IR code retrieved from either ROM or RAM is sent by the microprocessor to IR transmitters 1328 and is transmitted.

Before the custom controller can be used as a complete universal remote control, it must be programmed with the IR codes for the functions and the brand and models of home electronic equipment it is going to control. Traditionally this has been done in two different ways. First, the custom controller can "learn" the IR codes for the products that it is to control from the remote controls that come with each product. The custom controller would then also include an IR receiver (not shown) that would receive IR codes from other remote controls and store these codes and which button on the custom controller each code is associated with into RAM. This type of "learning" controller usually employs the schematic of FIG. 58. The second traditional programming

method involves providing a ROM that contains the IR codes for most functions of most brands and models of home electronic equipment. The user then enters into the custom controller what brand/model of each type of home electronic device that the user plans to use the custom controller with. In this method, for each brand and model of home electronic equipment, the custom controller will also include in ROM the associations between the IR codes for the equipment and the keys on the custom controller that will trigger the sending of the IR codes. A controller utilizing this second programming method usually employs the schematic of FIG. 59.

In an alternate embodiment, the custom controller can be programmed by either of both of these methods. IR codes that are "learned" from other remote controllers are store in RAM 1324 shown in FIG. 58. Alternatively, ROM 1332 shown in FIG. 1332 includes IR codes for most VCRs, cable boxes, satellite receivers, televisions and stereo components and the ability to program which brand/model of these device he or she is using. In yet another embodiment, the embodiments shown in FIGS. 58 and 59 can be combined by including a flag bit in the data stored in RAM 1324 or 1330. If the flag bit is set, the rest of the data at that address is a ROM address which points to the location of the IR code in ROM 1332. If the flag bit is not set, the rest of the data at that address contains actual IR code data.

In the preferred embodiment of FIGS. 53-60, though, IR codes are programmed into the memory of the custom controller through the microphone 1308 that is used for the set up of the channel map, cable box and VCR brand/model and the current time of day. Using the process shown in FIG. 60, a process similar to that described above in connection with the custom programmer 1100, in block 1340, the user calls either a special phone number which could be a toll-free 800 number, a pay-per-minute 900 number, or a standard telephone number

with standard toll charges applying. In block 1342, the consumer speaks on the telephone to a customer service representative (representative) located at a remote site who orally inquires from the consumer the information regarding the brand and model of each home electronic device with which the consumer wants to use custom controller. In blocks 1346 and 1348, the consumer also has the opportunity to tell the representative which functions each button of the control surfaces 1302 and 1304 is to perform. In block 1350, the representative enters this information into a computer at the remote site. If the consumer does not have preferences regarding which button of the custom controller is used to perform which functions, in block 1352, the representative does not enter any preferences into the computer and the computer relies on default associations between the buttons and functions that are previously stored in the computer.

Once this information has been entered into the computer, in block 1354 the computer programs the custom programmer in at least two different ways, depending on whether the embodiment of FIG. 58 or 59 is used. If the embodiment of FIG. 58 is used, the computer downloads, through microphone assembly 1334 in either manner described above in connection with the custom programmer and shown in FIGS. 43 and 44, all of the necessary IR codes into RAM 1324 at the addresses associated with the buttons on the keyboard 1320 according to the consumer's expressed wishes. If this method is used, no IR codes need be stored in the ROM of the custom controller when it is manufactured.

If the embodiment of FIG. 59 is used, the ROM 1332 installed into the custom controller at manufacture is programmed with the IR codes of many different brands, models and types of home electronic devices. In this case, the computer downloads, through microphone assembly 1334, the addresses of the ROM for all of the necessary IR

codes into RAM 1330 instead of downloading the IR codes themselves.

In an alternative embodiment the ROM 1332 contains default associations between IR codes and buttons of the custom controller, so that these associations need not be downloaded unless the consumer has requested associations between buttons and IR codes that are different from the default associations. This method reduces the amount of data that needs to be sent over the telephone lines from the remote site to the custom controller, but can increase the size and cost of the ROM installed in the custom controller. In the rare case where the IR codes for the device that the consumer wants to control are not included in the ROM, the computer would just download the IR codes themselves for that device as in the first programming method described above with reference to FIG. 58.

It is noted above that in either of the embodiments shown in FIGS. 58 and 59, the microphone and decoding assemblies from either FIG. 43 or FIG. 44 may be used. Preferably, the microphone and decoding assembly in FIG. 44 is used as it is less expensive than the assembly in FIG. 43 that uses a DTMF decoder 1166. The system shown in FIG. 44 utilizes just two single frequency signals rather than many dual frequency signals as in a DTMF system. The first signal, a tone of approximately 3000 Hz, is used to signify a binary "one" and the second signal, a tone of approximately 500 Hz, is used to signify "zero." Since a 500 Hz signal is being used in this embodiment, the bandwidth of the 1000 - 5000 Hz high pass filter 1168 from FIG. 44 will have to be broadened to include 500 Hz when included in the microphone and decoder assembly 1334.

A series of these two tones are transmitted over the telephone line, representing a binary series. A short period of no signal is included between each tone in the series of tones so that two consecutive 500 Hz or two consecutive 3000 Hz signals are interpreted as two

sequential signals and not one long signal. In an alternative embodiment, the series of signal tones are sent at a predetermined clock speed.

A decoder (not shown) is included between the microphone assembly 1334 and the microprocessor 1322 that converts the 3000 Hz signals to high electrical signals and converts the 500 Hz signals to low electrical signals that are sent to a serial input into the microprocessor. A clock signal is simultaneously sent to the microprocessor with each high or low signal.

Alternatively, the initial set-up programmer 1200 could be used to perform the IR code programming of the custom controller 1300 instead of using the microphone/telephone interface.

The custom controller has several additional features. First, the rear surface 1312 of the custom controller is large enough so that custom controller can be set on the rear surface as shown in FIG. 61 and resist tipping over. The advantage of being able to stand the custom controller in this upright position is that IR transmitters 1314 are then at a substantial height above the surface on which the custom controller is set. This lessens the probability that pillows, newspapers, magazines or other debris will be inadvertently placed on top of the custom controller as it will be difficult for debris to balance on the top of the custom controller when while in the upright position. Further, stacks of pillows, magazines and other debris placed next to the custom controller must be rather high before they will block the IR transmissions of the custom controller. This feature is extremely important because, unlike the instant programmer which can have a permanent holder next to the cable box and VCR, away from magazines and pillows, the custom controller, having full universal remote capabilities, is designed to be used some distance away from the video equipment. Yet, to function properly as an automatic video recorder controller, the IR transmitters

of the custom controller need to have a direct line of sight to the IR receivers of the video equipment to be controlled.

The degree of enlargement of the rear surface 1312 needs to be enough so that the custom controller is stable and resistant to being tipped over when it is put in the upright position shown in FIG. 58. Determining an acceptable size of rear portion is based on several factors. First, it usually desirable for the length and the width of the rear surface to be approximately equal. If the length is significantly greater than the width (as is the case with traditional prior art universal remote controls), the controller can be easily tipped over along the axes that span the width of the rear surface. Next, the proportion of the height of the controller to the length and width of the rear surface cannot be too great. A ratio of the length of the rear face to the height of the controller and of the width of the rear face to the height of the controller of approximately 3 to 1 or less is usually sufficient. However, this ratio depends on the uniformity of the density of the custom controller and thus the center of gravity. If the upper portions of the custom controller (when it is in the upright position) are more dense than the lower portions, the center of gravity will be high and the ratio of the width and length of the rear surface will need to be reduced. On the other hand, if the lower portions are more dense, the center of gravity will be lower and the ratio can be safely increased. One way the center of gravity is lowered in the custom controller is by placing the batteries 1316, which are comparatively very dense, very near the rear surface.

Another factor in the stability of the custom controller in the lateral location of the custom controller's center of gravity. The closer the center of gravity is to being directly above the center of the rear surface when the custom controller is in the upright

position, the more stable the custom controller will be. It is noted that the upper portion of embodiment of the custom controller shown in FIGS. 53-58 is off center. This moves the center of gravity away from the center of rear surface slightly, but adds to the aesthetic appearance of the custom controller.

The shape of the rear surface is not particularly relevant, but rather the shortest distance across the rear surface. On the other hand, the shape of the back surface of the custom controller is significant. Preferably, the back surface is semicircular or substantially semicircular. The closer the back surface is to a semicylindrical shape, the more comfortable the custom controller is for a consumer to hold, as the cylindrical shape fits better into human hands.

Another feature of the custom controller is its two control surfaces 1302 and 1304. Auxiliary control surface 1304 is designed to include buttons that will be used most often when the custom controller is in its upright position, such as volume up and down controls. The angle between the rear surface and the auxiliary control surface is less than or equal to 45°. Keeping the angle less than or equal to 45° directs at least half of the force needed to press button on the auxiliary control surface downwards into the table or other surface the custom controller is resting on instead of sideways, which would tend to topple the custom controller when it is in the upright position.

Two alternative embodiments of the custom controller 1300 are shown in FIGS. 65-70 and FIGS. 71-76. These controllers include control faces that are at angles from the rear face of less than or equal to 45°, substantially circular bottom faces and rear faces that are larger relative to prior art remote controls.

Yet another feature of the custom controller are one touch channel tuning buttons. These buttons would be assigned to a specific television or cable channel such as HBO, ESPN, CNN or MTV. For example, if a button is

assigned to CNN, when the CNN button is pressed, the custom controller transmits IR codes to change the channel on a television, VCR, cable box or satellite receiver to the channel number on which CNN is broadcast. When the consumer sets up the custom controller, he or she tells the representative what channels he or she watches the most and the representative directs the computer to have selected keys on the custom controller be programmed to tune these channels. The consumer tells the representative which keys on the custom controller he or she wishes to tune which channels or the representative can select the keys. After the keys and channels have been selected, the consumer then writes the channel names next to the keys that tune them or labels with different channel names can be supplied which are then applied to the custom controller next to the appropriate buttons. These one touch tuning buttons are particularly well suited to being programmed as buttons on the auxiliary control surface, so that the consumer can operate these buttons without having to pick up the custom controller.

It is thought that the universal remote that includes apparatus and method using compressed codes for television program record scheduling of the present invention and many of its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the parts thereof without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred or exemplary embodiment thereof.

WHAT IS CLAIMED IS:

1. A remote control for transmitting control codes for control of home electronic devices and for using compressed codes for automatically recording video signals, by a video recorder, under control of sets of channel, date, time-of-day and length commands, the remote control comprising:

means for entering compressed codes, each representative of, and compressed in length from, a set of individual channel, date, time-of-day and length commands;

means for decoding said compressed codes into sets of individual channel, date, time-of-day and length commands;

a keypad comprising a plurality of buttons;

means for storing control codes for control of home electronic devices and for storing associations between said buttons and said control codes

means for retrieving from said storing means, when one of said buttons is activated, any such control codes associated with such activated button;

a transmitter for transmitting retrieved control codes and for transmitting record on, record off and channel select control codes according to said individual channel, date, time-of-day and length commands; and

means for receiving said control codes and said associations between said control codes and said buttons for storage in said means for storing.

2. The remote control of claim 1 wherein said means for receiving are coupled to a computer.

3. The remote control of claim 1 wherein said means for receiving are coupled to a computer through a telephone line.

4. The remote control of claim 1:

wherein said means for storing further comprise means for storing at least one local channel number for at least one channel number in said channel command; and

wherein said means for receiving further comprise means for receiving local channel numbers corresponding to channels numbers in said channel commands and the correlation of said local channel numbers to said channel numbers in said channel commands for storage in said means for storing; and

wherein said transmitter transmits said channel commands according to local channel numbers stored in said storing means to said means for channel selection according to said individual date, time-of-day and channel commands.

5. The remote control of claim 4 wherein said means for receiving are coupled to a computer.

6. The remote control of claim 4 wherein said means for receiving are coupled to a computer through a telephone line.

7. The remote control of claim 1 further comprising:

a clock;

means for setting said clock according to signals representative of time;

wherein said means for receiving further comprise means for receiving said signals representative of time.

8. The remote control of claim 7 wherein said means for receiving are coupled to a computer.

9. The remote control of claim 7 wherein said means for receiving are coupled to a computer through a telephone line.

10. A remote control comprising:

a rear face;

a bottom face connected to said rear face;

a top face connected to said rear face;

at least one transmitter located at the end of the top face opposite said connection to said rear face;

wherein the length of the top face, measured from said connection to said rear face to the opposite end of said top face is greater than the minimum of the length and width of the rear face.

11. The remote control of claim 10 wherein said top face comprises a substantially flat control surface. including buttons, that is at an angle of less than forty-five degrees from said rear face.

13. The remote control of claim 10 further comprising batteries, fixed in a position substantially adjacent to said rear face.

12. A method of programming a universal remote control with control codes for controlling a home electronic device comprising:

entering information sufficient to identify the control codes needed to control said home electronic device into a computer;

downloading said control codes through an audio connection from said computer to said universal remote control.

APPARATUS AND METHOD USING COMPRESSED CODES FOR TELEVISION PROGRAM RECORD SCHEDULING

Abstract of the Disclosure

Encoded video recorder/player timer preprogramming information listed in a television calendar allows a timer preprogramming feature on a video cassette recorder VCR to be programmed using a compressed code of as few as 1 to 8 digits, which are decoded by a decoder built into a remote control, video cassette recorder, television or other video device to convert the compressed code into channel, date, time and length information. The channel, date, time and length information is used to select channels, start recording, and stop recording at the appropriate time. A local channel map is stored so that the channel information from the compressed codes can be utilized to tune the correct channel even though channel numbers in different localities may be different. The remote may be a universal remote control capable of selecting between various stored infrared code protocols for commanding different brands and model of video devices. The remote may also be a complete universal remote control that transmits infrared codes to a variety of home electronic devices upon the user pressing buttons associated with the functions associated with the infrared codes. The programming of local channel map data, infrared codes and protocols and their association with specific buttons on the remote control can be accomplished by the remote control's keyboard or by an external device, including external devices that accomplish the programming by transmissions over telephone lines.

82108813

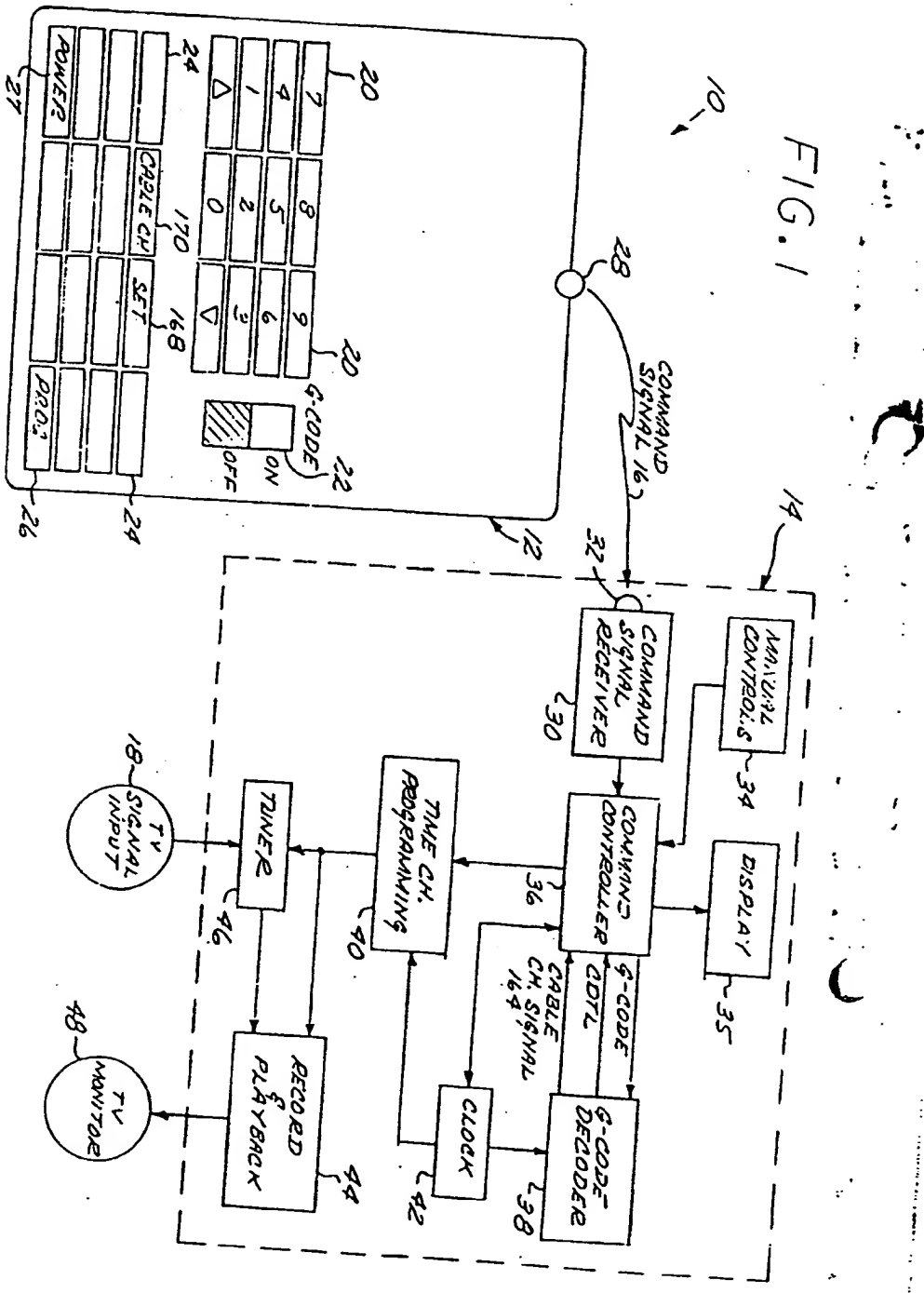


FIG. 1

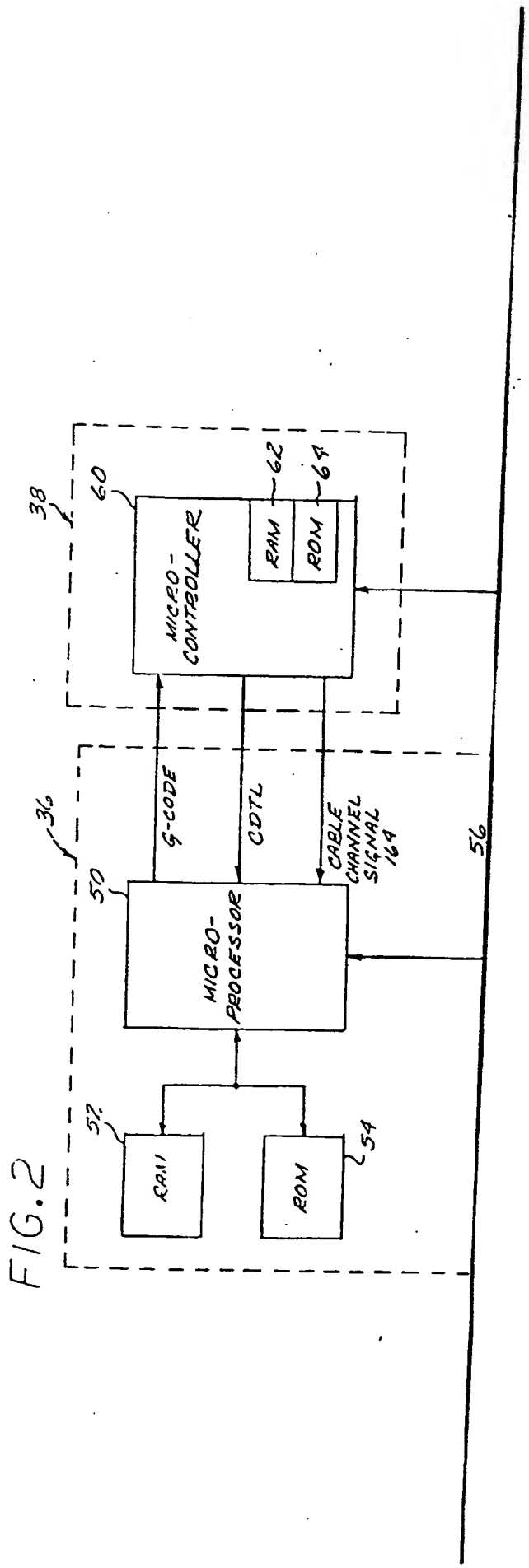


FIG. 2

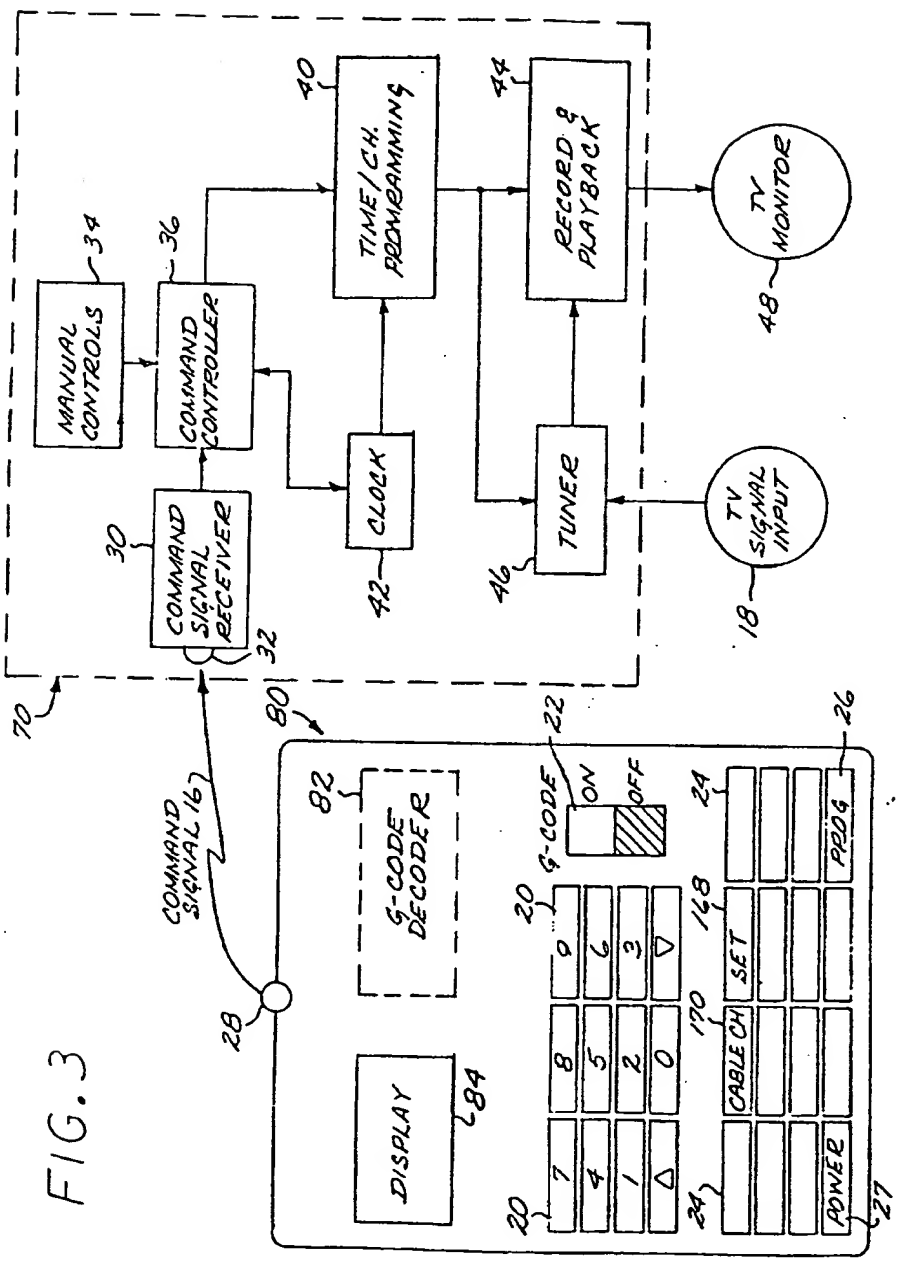


FIG. 3

FIG. 4

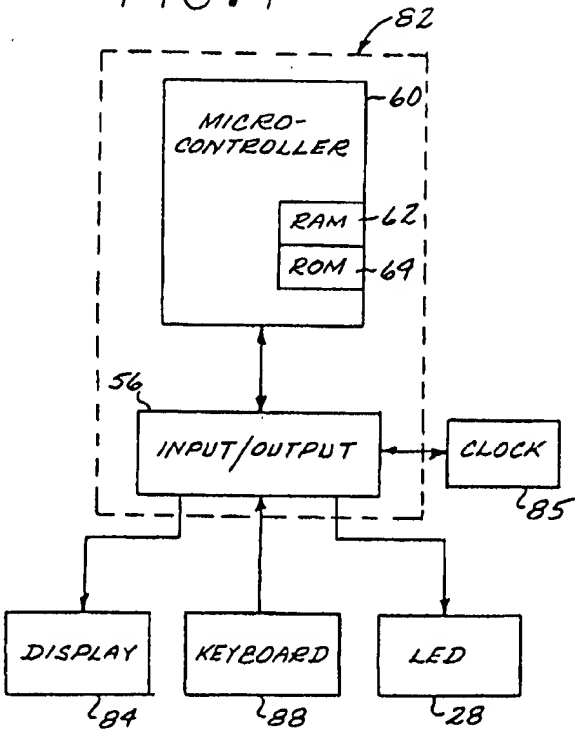
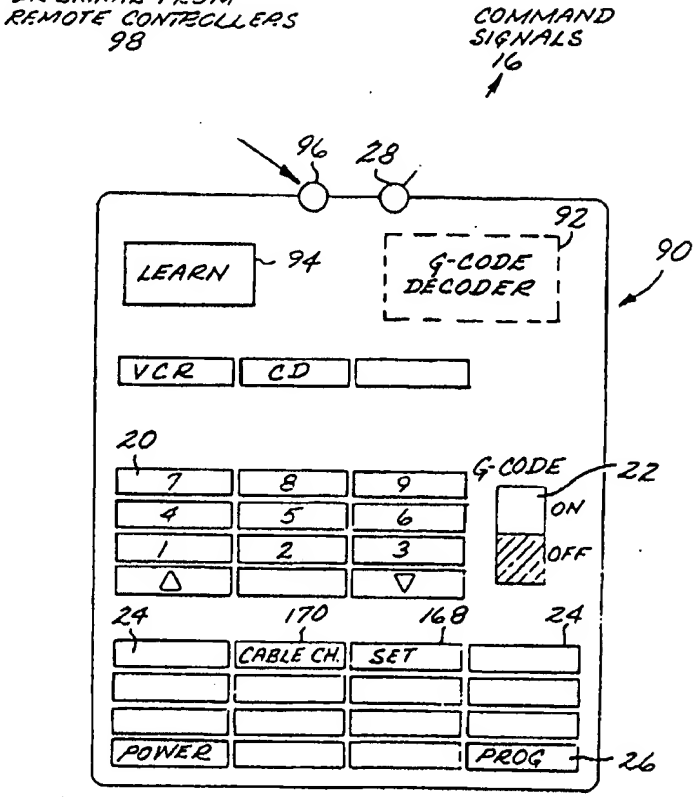


FIG. 5



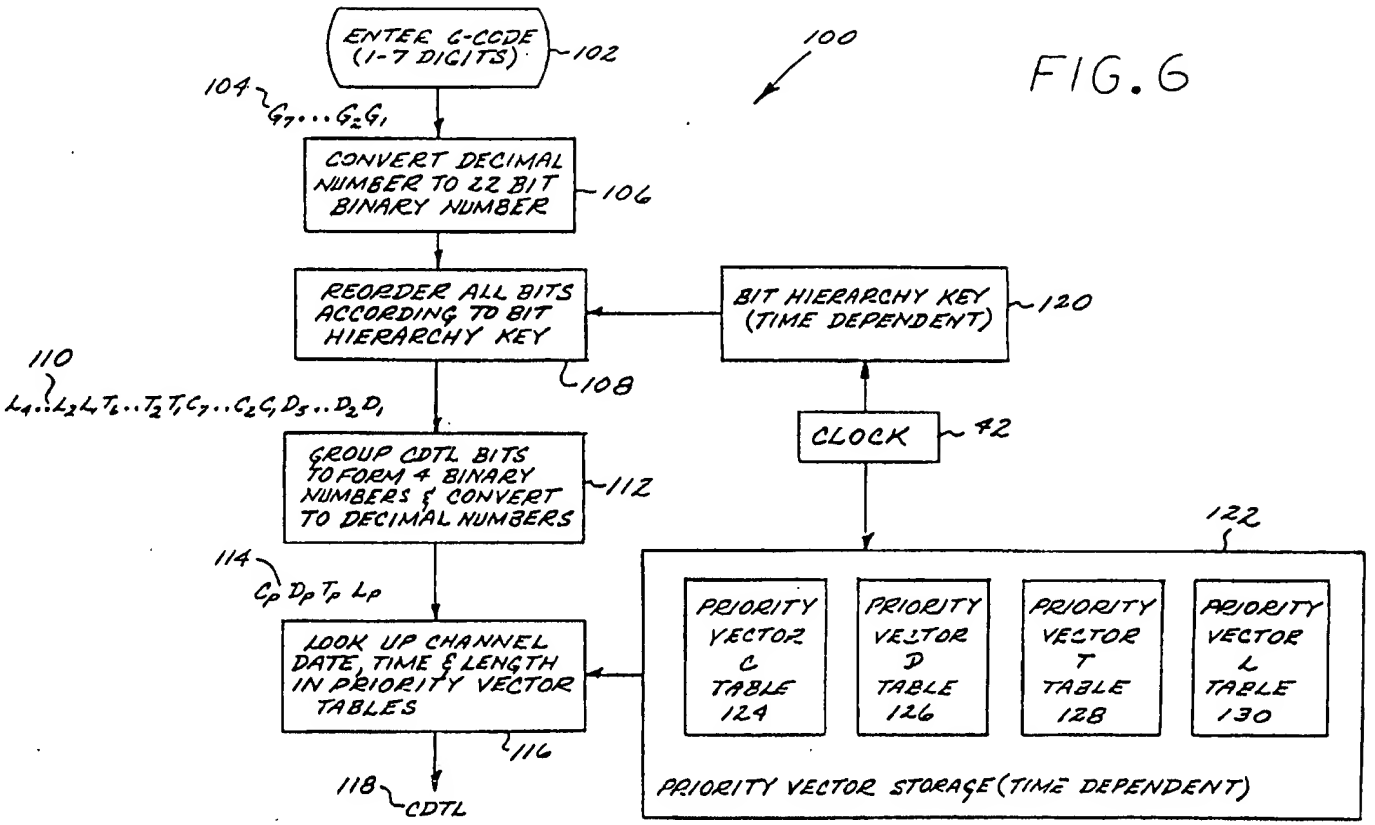

ENTER G-CODE (1-7 DIGITS)
102
100
104
$G_7 \ldots G_2 G_1$
CONVERT DECIMAL NUMBER TO 22 BIT BINARY NUMBER
106
REORDER ALL BITS ACCORDING TO BIT HIERARCHY KEY
108
BIT HIERARCHY KEY (TIME DEPENDENT)
120
110
$L_4 \ldots L_2 L_1 T_4 \ldots T_2 T_1 C_7 \ldots C_2 C_1 D_5 \ldots D_2 D_1$
CLOCK
42
GROUP CDTL BITS TO FORM 4 BINARY NUMBERS & CONVERT TO DECIMAL NUMBERS
112
122
114
$C_P D_P T_P L_P$
LOOK UP CHANNEL DATE, TIME & LENGTH IN PRIORITY VECTOR TABLES
116
PRIORITY VECTOR C TABLE 124
PRIORITY VECTOR D TABLE 126
PRIORITY VECTOR T TABLE 128
PRIORITY VECTOR L TABLE 130
PRIORITY VECTOR STORAGE (TIME DEPENDENT)
118
CDTL

FIG. 6

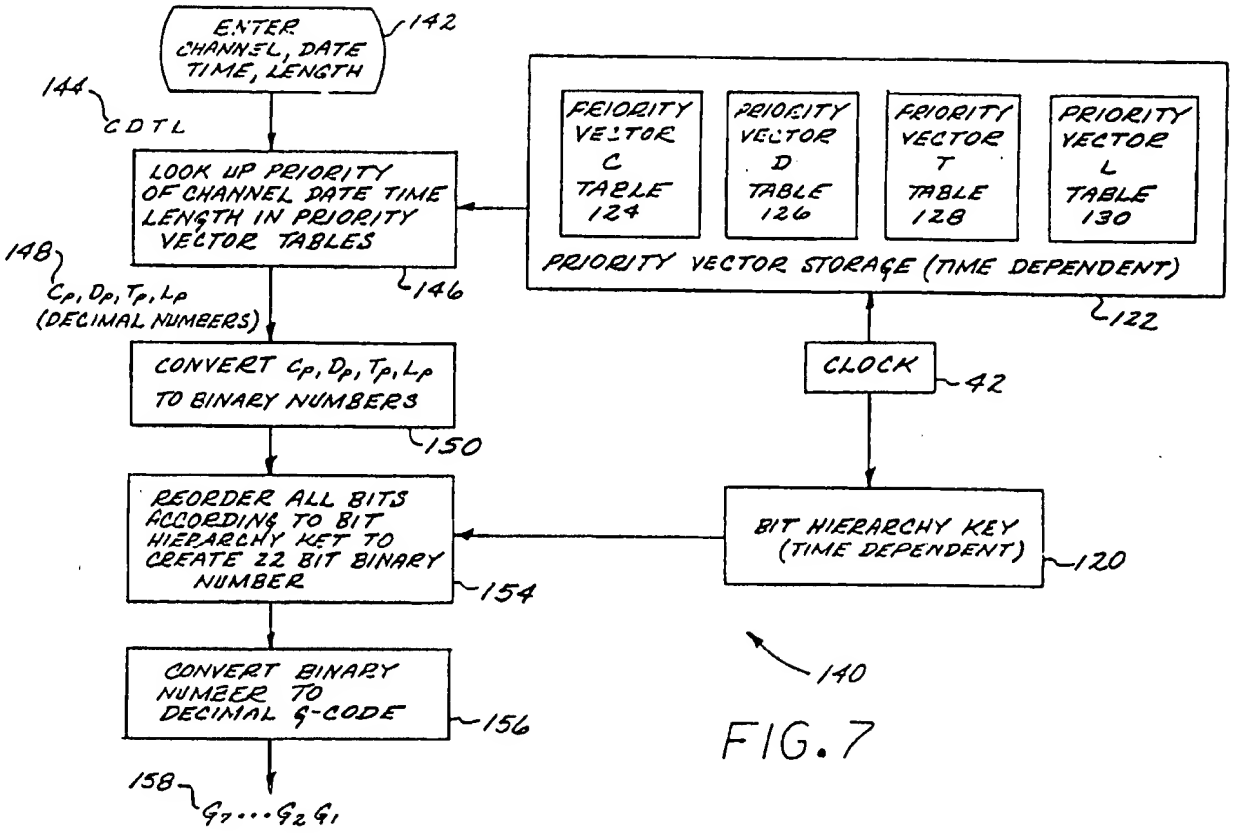

ENTER CHANNEL, DATE TIME, LENGTH
142
144
CDTL
LOOK UP PRIORITY OF CHANNEL DATE TIME LENGTH IN PRIORITY VECTOR TABLES
146
148
C_p, D_p, T_p, L_p (DECIMAL NUMBERS)
CONVERT C_p, D_p, T_p, L_p TO BINARY NUMBERS
150
REORDER ALL BITS ACCORDING TO BIT HIERARCHY KEY TO CREATE 22 BIT BINARY NUMBER
154
CONVERT BINARY NUMBER TO DECIMAL G-CODE
156
158
$G_7 \cdots G_2 G_1$
PRIORITY VECTOR C TABLE 124
PRIORITY VECTOR D TABLE 126
PRIORITY VECTOR T TABLE 128
PRIORITY VECTOR L TABLE 130
PRIORITY VECTOR STORAGE (TIME DEPENDENT)
122
CLOCK
42
BIT HIERARCHY KEY (TIME DEPENDENT)
120
140

FIG. 7

THURSDAY 204 FEBRUARY 9, 1989 202

203 [E] SPORTS RETROSPECTIVE; 60MIN. [68713]
6PM [27] NATURESCENE [5321]
206 A VISIT TO THE COLORADO NATIONAL MONUMENT
210 NEAR GRAND JUNCTION, WHERE WILDFLOWERS, INSECT AND BIRDS ARE OBSERVED
[34] [52] NOTICIAS [62921] [496649]
[40] DWIGHT THOMPSON--RELIGION; [68553]
[50] HUMANITIES THROUGH THE ARTS [493065]
[56] BEVERLY HILLBILLIES--COMEDY [496777]

200

FRIDAY 204 FEBRUARY 10, 1989 202

[CB] [DIS] MOVIE--DRAMA; 70MIN. (23627113)
6:30 [11] FAMILY TIES (CC)--COMEDY [15657]
206 MALLORY'S REUNION WITH HER COLLEGE BOY FRIEND (JOHN DUKAKIS) HAS HER WORRIED THAT SHE MAY NOT BE AS INTERESTING TO HIM AS SHE ONCE WAS.
208 [56] HOGAN'S HEROES - COMEDY [510857]
188 CARTERS MASQUERADE AS A TRAITOR MAY BE KAPUT: A LOVELY FRAULEIN IS TRYING TO POISON HIM
[C14] [NIK] DOUBLE DARE - GAME (29225)
[C11] [TNN] VIDEOCOUNTRY (29129)
[C7] [USA] CARTOON EXPRESS (23561)
7PM [5] CHARLES IN CHARGE (CC) - COMEDY [1065]
206 WHILE PLANNING A PIZZA-PALOOZA PARTY, CHARLES ALIENATES THE POWELL CHILDREN BY DISMISSING THEIR SUGGESTIONS ABOUT ORGANIZING THE EVENT.

200

212

FIG. 8

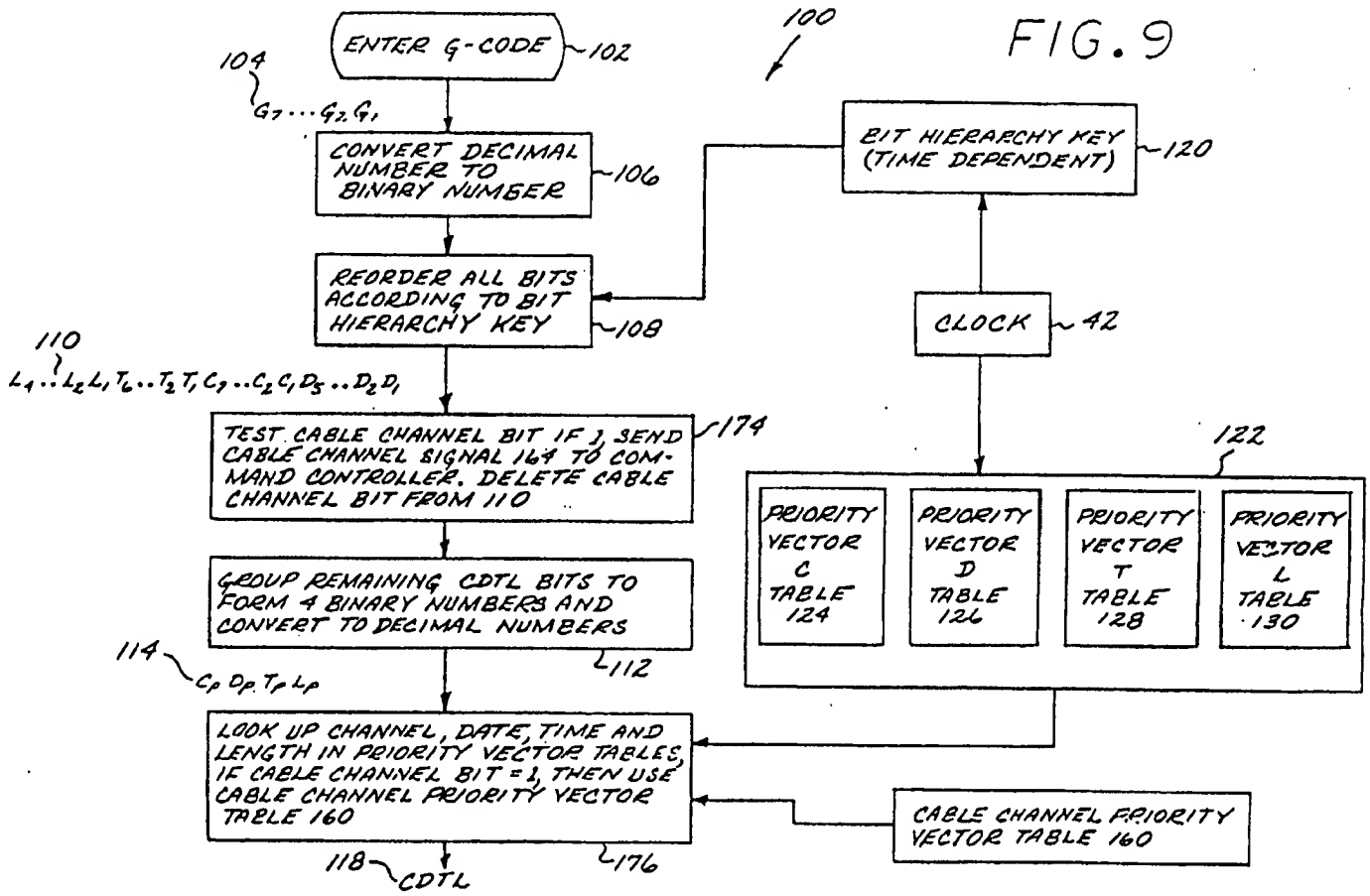

ENTER G-CODE
102
104
$G_7 \cdots G_2 G_1$
CONVERT DECIMAL NUMBER TO BINARY NUMBER
106
REORDER ALL BITS ACCORDING TO BIT HIERARCHY KEY
108
110
$L_4 \cdots L_2 L_1 T_6 \cdots T_2 T_1 C_7 \cdots C_2 C_1 D_5 \cdots D_2 D_1$
TEST CABLE CHANNEL BIT IF 1, SEND CABLE CHANNEL SIGNAL 164 TO COMMAND CONTROLLER. DELETE CABLE CHANNEL BIT FROM 110
174
GROUP REMAINING CDTL BITS TO FORM 4 BINARY NUMBERS AND CONVERT TO DECIMAL NUMBERS
112
114
$C_P D_P T_P L_P$
LOOK UP CHANNEL, DATE, TIME AND LENGTH IN PRIORITY VECTOR TABLES, IF CABLE CHANNEL BIT = 1, THEN USE CABLE CHANNEL PRIORITY VECTOR TABLE 160
176
118
CDTL
100
BIT HIERARCHY KEY (TIME DEPENDENT)
120
CLOCK
42
122
PRIORITY VECTOR C TABLE 124
PRIORITY VECTOR D TABLE 126
PRIORITY VECTOR T TABLE 128
PRIORITY VECTOR L TABLE 130
CABLE CHANNEL PRIORITY VECTOR TABLE 160

FIG. 9

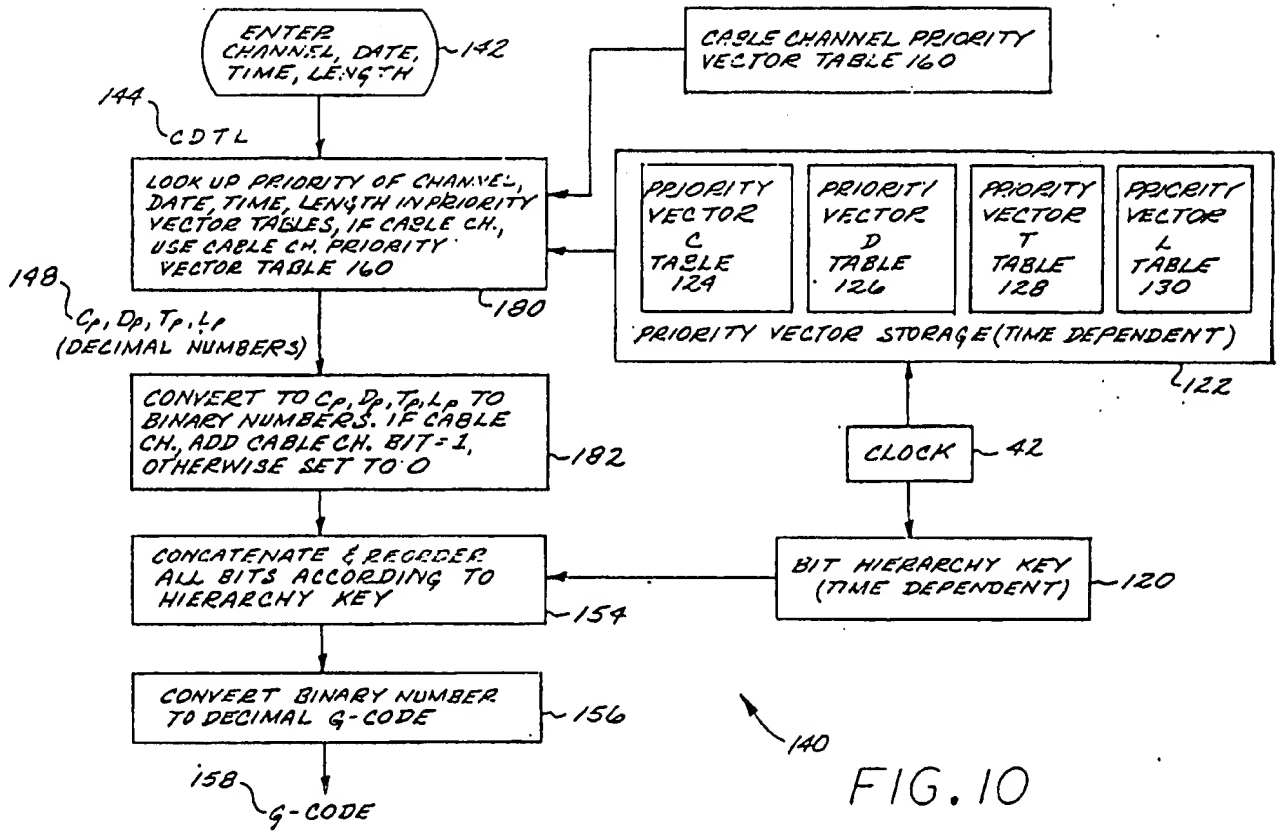

ENTER CHANNEL, DATE, TIME, LENGTH
142
144
CDTL
LOOK UP PRIORITY OF CHANNEL, DATE, TIME, LENGTH IN PRIORITY VECTOR TABLES, IF CABLE CH., USE CABLE CH. PRIORITY VECTOR TABLE 160
180
148
Cp, Dp, Tp, Lp (DECIMAL NUMBERS)
CONVERT TO Cp, Dp, Tp, Lp TO BINARY NUMBERS. IF CABLE CH., ADD CABLE CH. BIT = 1, OTHERWISE SET TO 0
182
CONCATENATE & REORDER ALL BITS ACCORDING TO HIERARCHY KEY
154
CONVERT BINARY NUMBER TO DECIMAL G-CODE
156
158
G-CODE
CABLE CHANNEL PRIORITY VECTOR TABLE 160
PRIORITY VECTOR C TABLE 124
PRIORITY VECTOR D TABLE 126
PRIORITY VECTOR T TABLE 128
PRIORITY VECTOR L TABLE 130
PRIORITY VECTOR STORAGE (TIME DEPENDENT)
122
CLOCK
42
BIT HIERARCHY KEY (TIME DEPENDENT)
120
140

FIG. 10

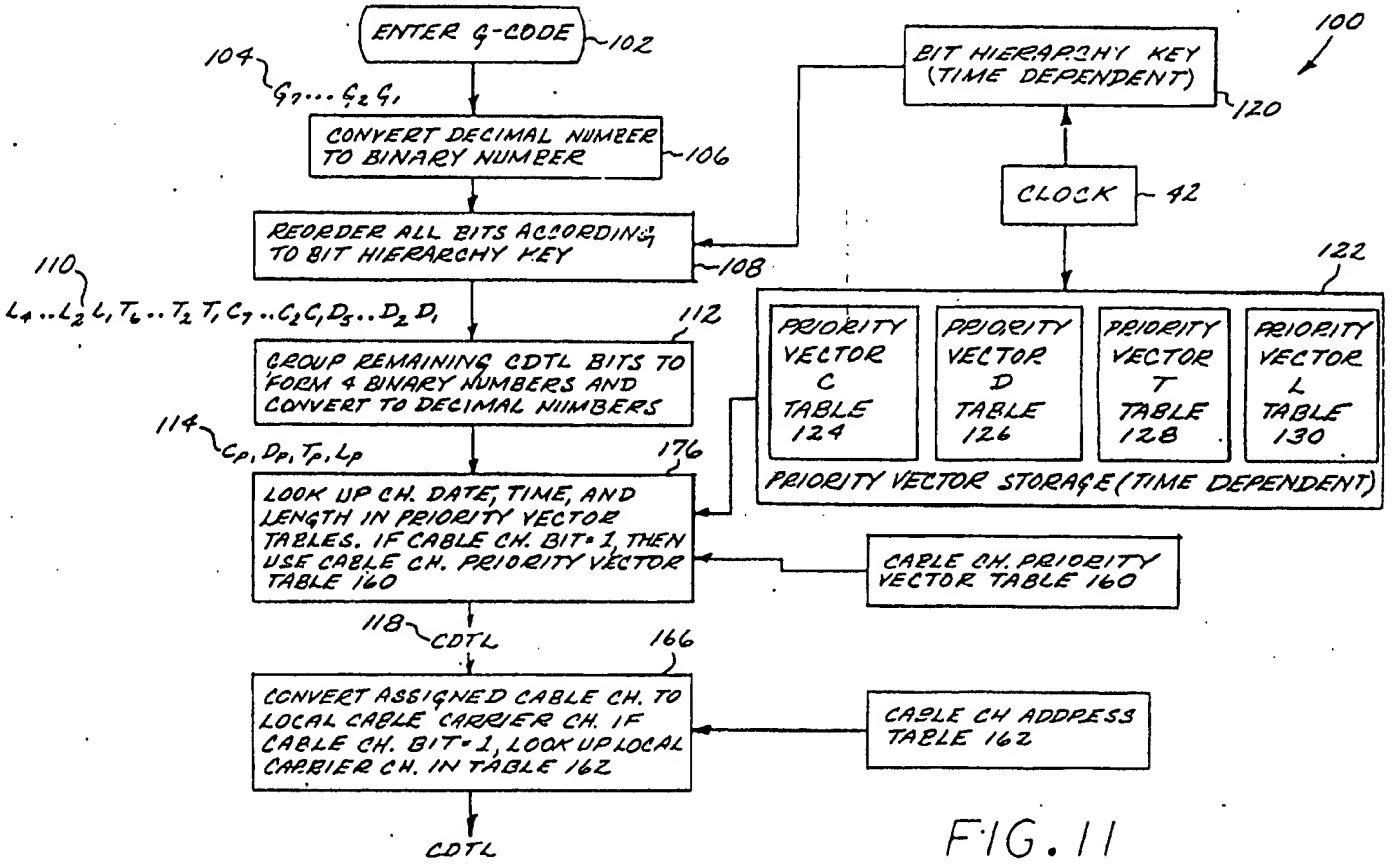

ENTER G-CODE
102
104
$G_7 \ldots G_2 G_1$
CONVERT DECIMAL NUMBER TO BINARY NUMBER
106
REORDER ALL BITS ACCORDING TO BIT HIERARCHY KEY
108
110
$L_4 \ldots L_2 L_1 T_6 \ldots T_2 T_1 C_7 \ldots C_2 C_1 D_5 \ldots D_2 D_1$
112
GROUP REMAINING CDTL BITS TO FORM 4 BINARY NUMBERS AND CONVERT TO DECIMAL NUMBERS
114
C_p, D_p, T_p, L_p
176
LOOK UP CH. DATE, TIME, AND LENGTH IN PRIORITY VECTOR TABLES. IF CABLE CH. BIT = 1, THEN USE CABLE CH. PRIORITY VECTOR TABLE 160
118
CDTL
166
CONVERT ASSIGNED CABLE CH. TO LOCAL CABLE CARRIER CH. IF CABLE CH. BIT = 1, LOOK UP LOCAL CARRIER CH. IN TABLE 162
CDTL
BIT HIERARCHY KEY (TIME DEPENDENT)
120
100
CLOCK
42
122
PRIORITY VECTOR C TABLE 124
PRIORITY VECTOR D TABLE 126
PRIORITY VECTOR T TABLE 128
PRIORITY VECTOR L TABLE 130
PRIORITY VECTOR STORAGE (TIME DEPENDENT)
CABLE CH. PRIORITY VECTOR TABLE 160
CABLE CH ADDRESS TABLE 162

FIG. 11

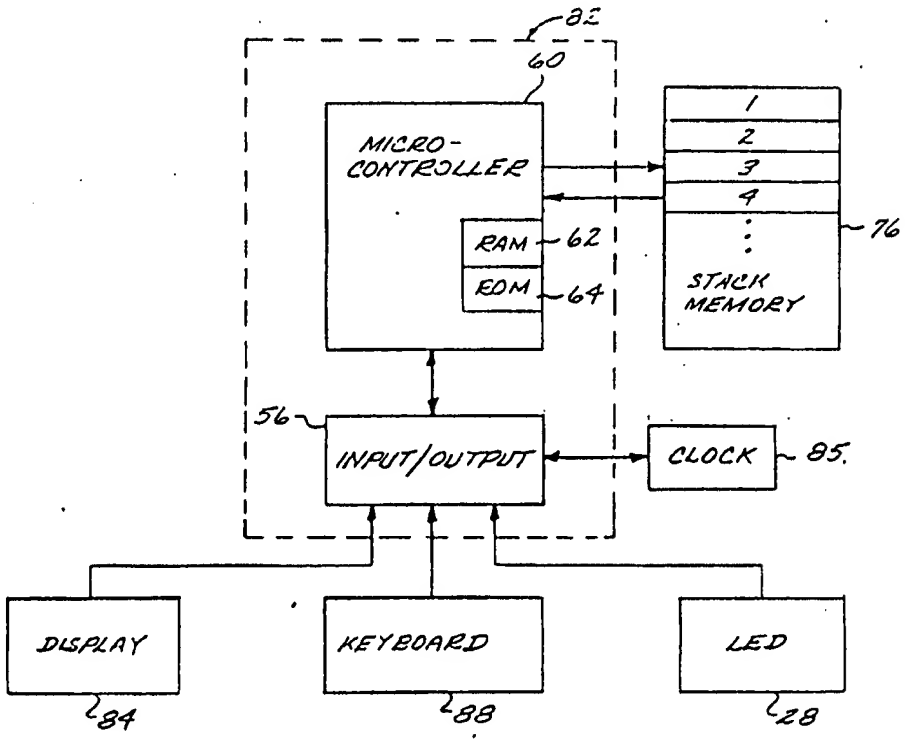

82
60
MICRO-
CONTROLLER
RAM
62
EOM
64
1
2
3
4
76
STACK
MEMORY
56
INPUT/OUTPUT
CLOCK
85
DISPLAY
84
KEYBOARD
88
LED
28

FIG. 12

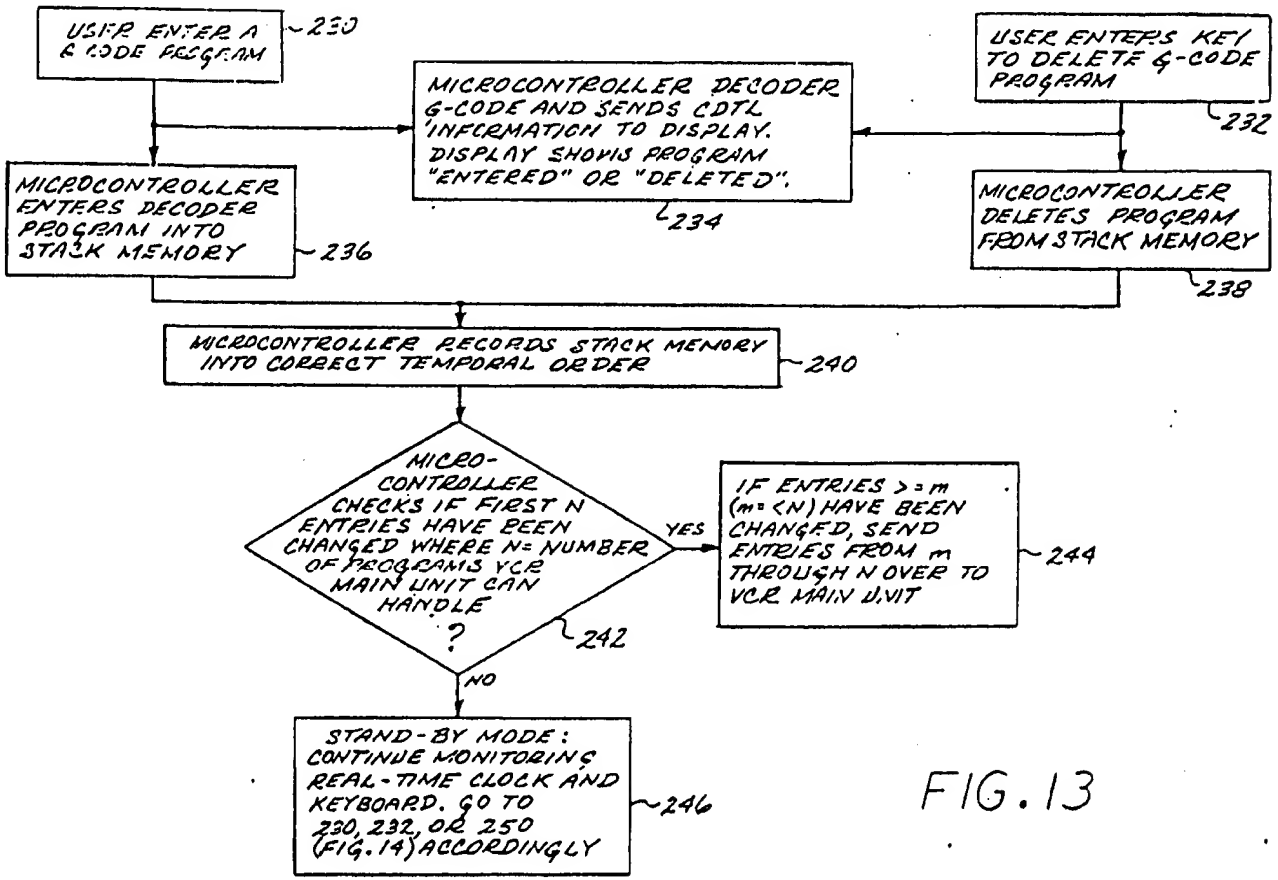

USER ENTER A G-CODE PROGRAM
230
MICROCONTROLLER DECODER G-CODE AND SENDS CDTL INFORMATION TO DISPLAY. DISPLAY SHOWS PROGRAM "ENTERED" OR "DELETED".
234
USER ENTERS KEY TO DELETE G-CODE PROGRAM
232
MICROCONTROLLER ENTERS DECODER PROGRAM INTO STACK MEMORY
236
MICROCONTROLLER DELETES PROGRAM FROM STACK MEMORY
238
MICROCONTROLLER RECORDS STACK MEMORY INTO CORRECT TEMPORAL ORDER
240
MICRO-CONTROLLER CHECKS IF FIRST N ENTRIES HAVE BEEN CHANGED WHERE N= NUMBER OF PROGRAMS VCR MAIN UNIT CAN HANDLE ?
242
YES
IF ENTRIES >= m (m=<N) HAVE BEEN CHANGED, SEND ENTRIES FROM m THROUGH N OVER TO VCR MAIN UNIT
244
NO
STAND-BY MODE: CONTINUE MONITORING REAL-TIME CLOCK AND KEYBOARD. GO TO 230, 232, OR 250 (FIG. 14) ACCORDINGLY
246

FIG. 13

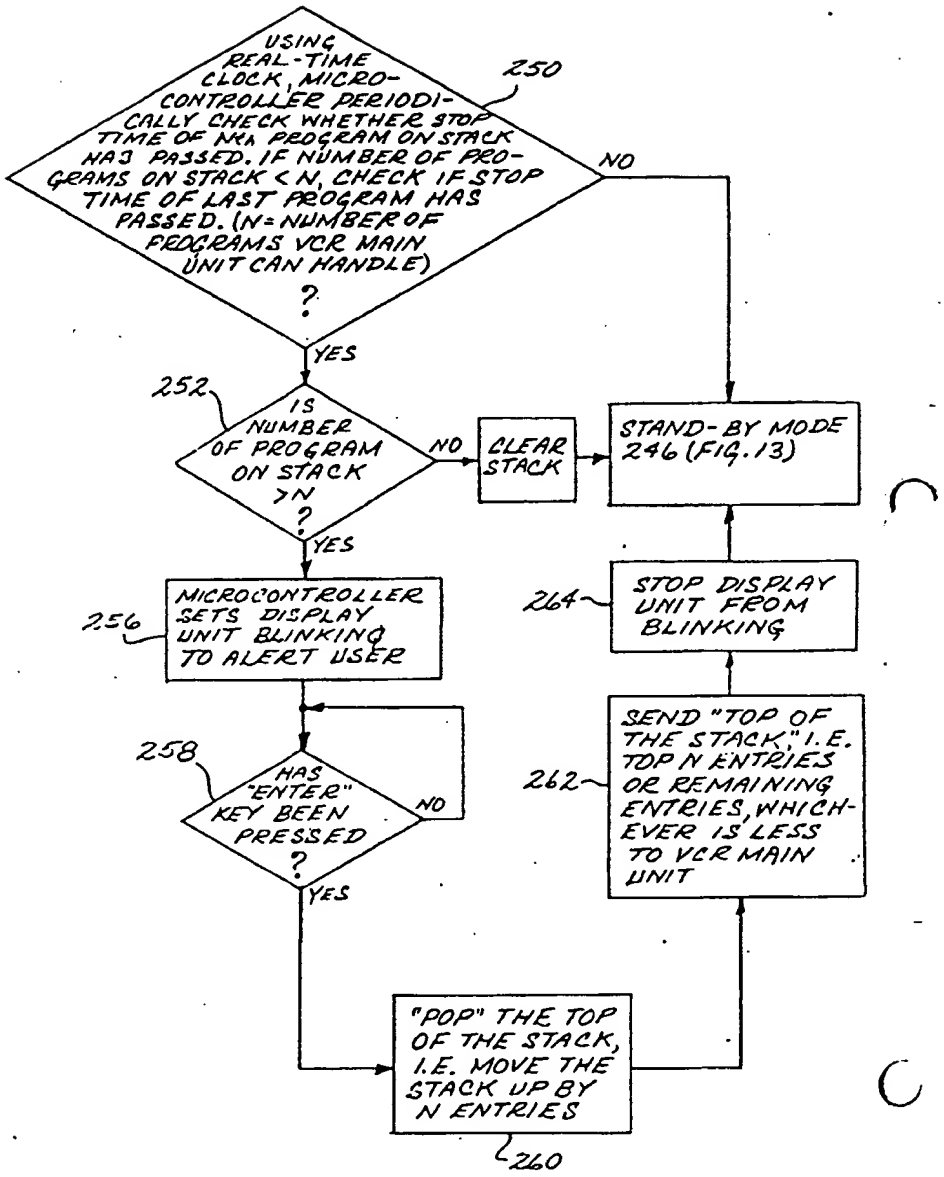

USING REAL-TIME CLOCK, MICRO-CONTROLLER PERIODICALLY CHECK WHETHER STOP TIME OF NA1 PROGRAM ON STACK HAS PASSED. IF NUMBER OF PROGRAMS ON STACK < N, CHECK IF STOP TIME OF LAST PROGRAM HAS PASSED. (N = NUMBER OF PROGRAMS VCR MAIN UNIT CAN HANDLE) ?
250
NO
YES
252
IS NUMBER OF PROGRAM ON STACK > N ?
NO
CLEAR STACK
STAND-BY MODE 246 (FIG. 13)
YES
256
MICROCONTROLLER SETS DISPLAY UNIT BLINKING TO ALERT USER
264
STOP DISPLAY UNIT FROM BLINKING
258
HAS "ENTER" KEY BEEN PRESSED ?
NO
YES
262
SEND "TOP OF THE STACK," I.E. TOP N ENTRIES OR REMAINING ENTRIES, WHICHEVER IS LESS TO VCR MAIN UNIT
"POP" THE TOP OF THE STACK, I.E. MOVE THE STACK UP BY N ENTRIES
260

FIG. 14

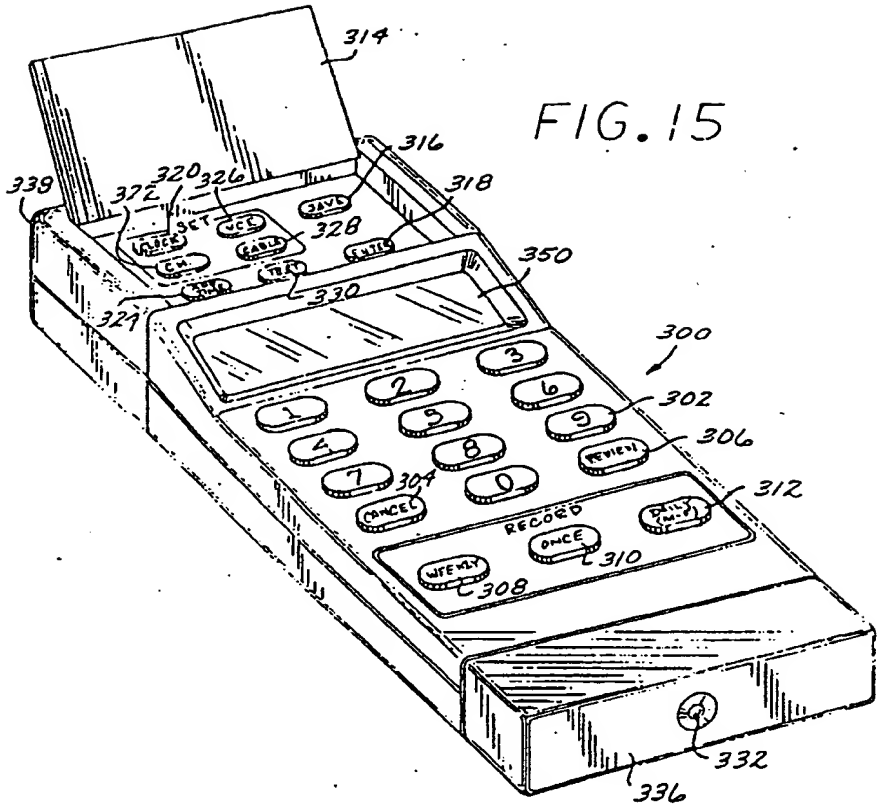
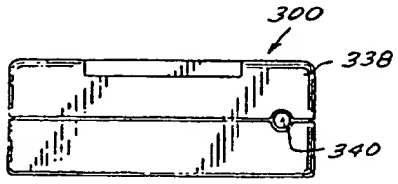

314
316
318
320
326
328
339
372
330
350
321
300
302
306
304
312
310
308
332
336
SET
CLOCK
SAVE
ENTER
CANCEL
REVIEW
RECORD
ONCE
WEEKLY
DAILY

FIG. 15

FIG. 16


300
338
340

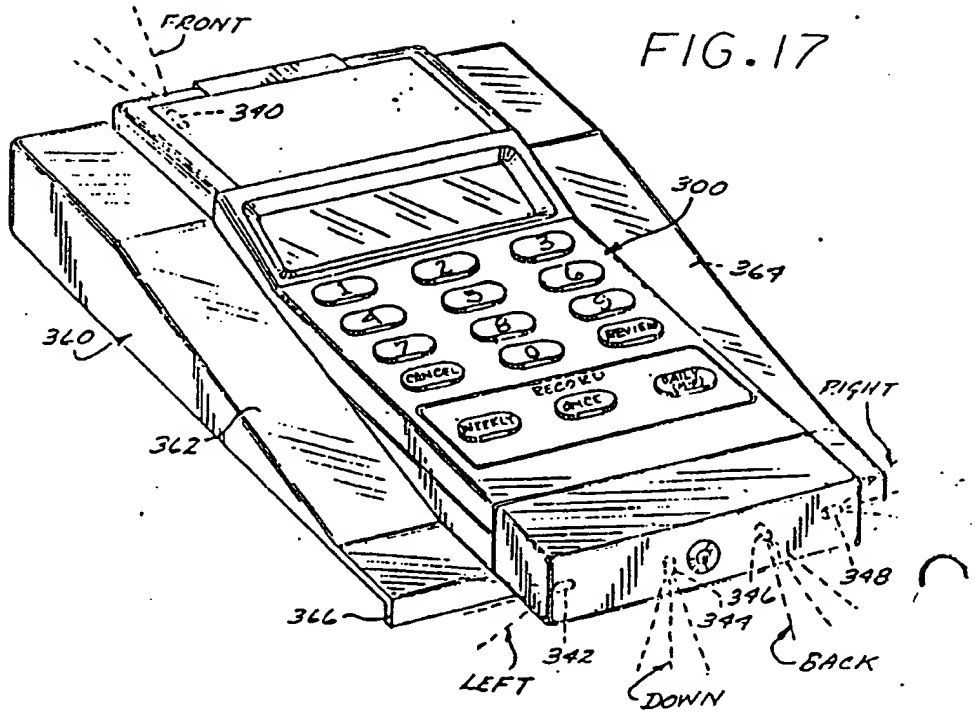


FIG. 17

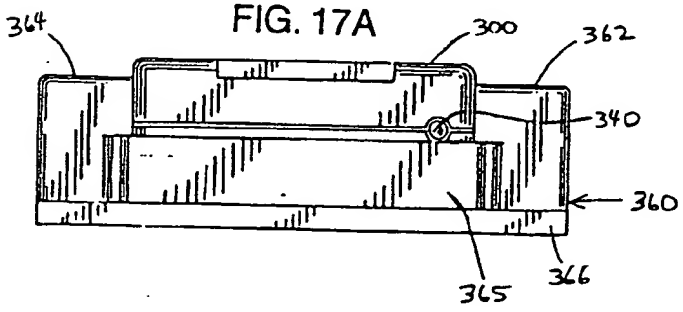
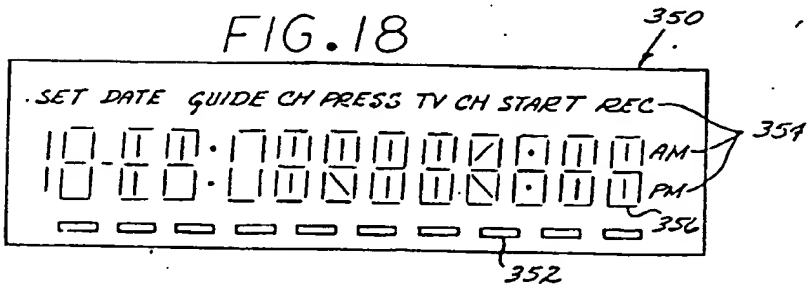


FIG. 17A

FIG. 18



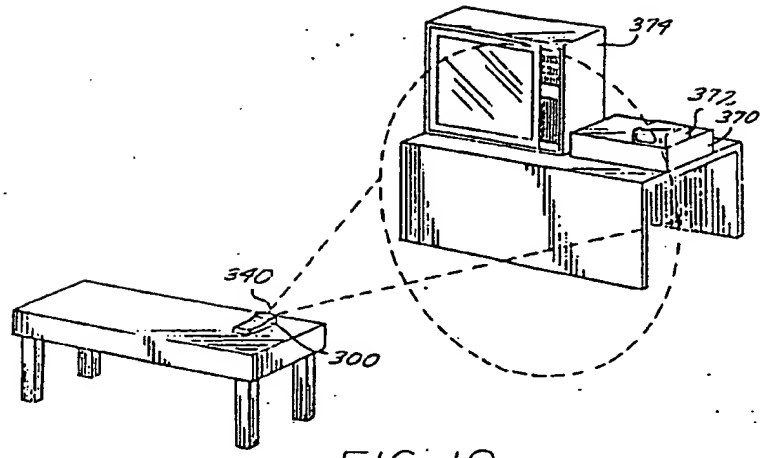


FIG. 19

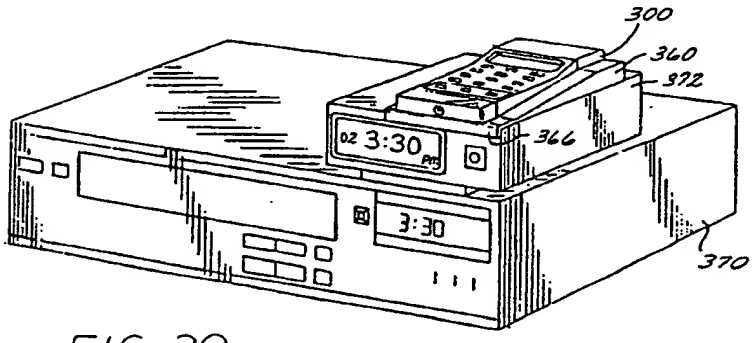


FIG. 20

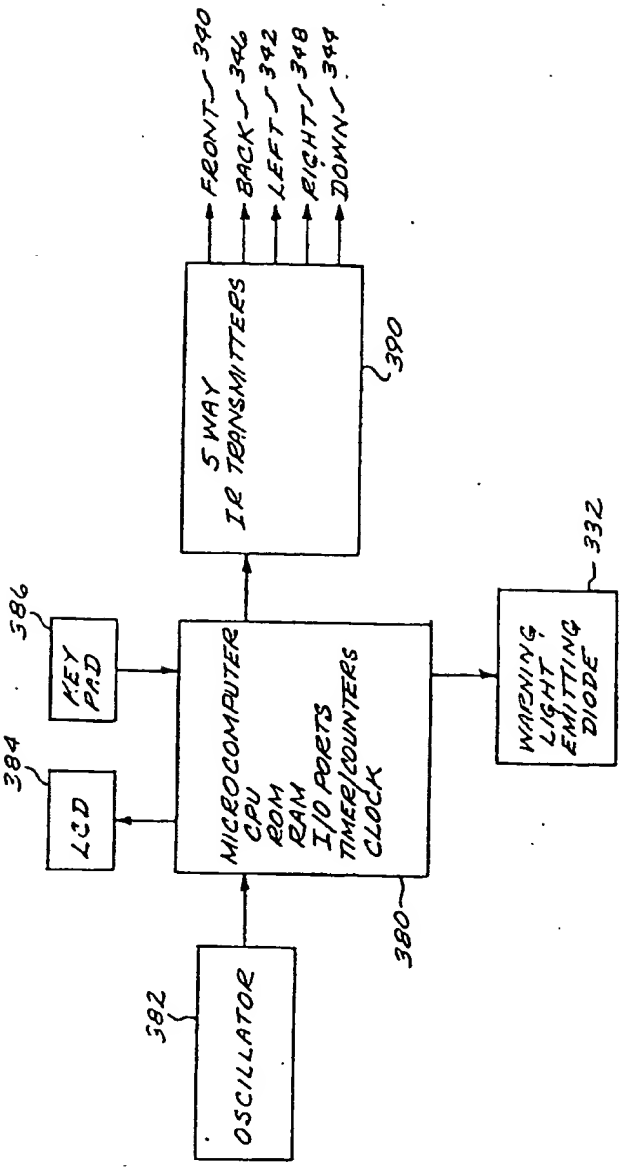


FIG. 21

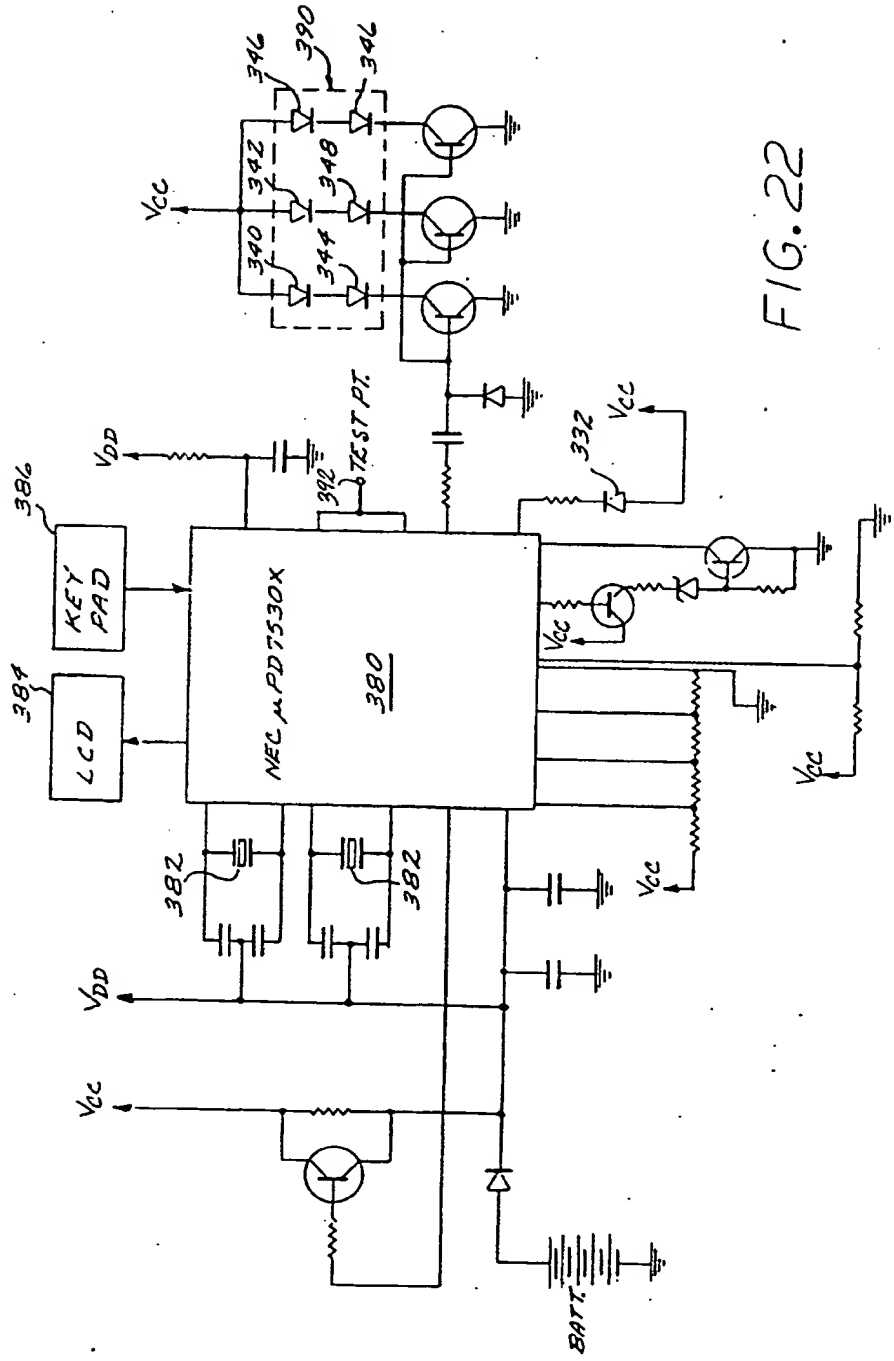


FIG. 22

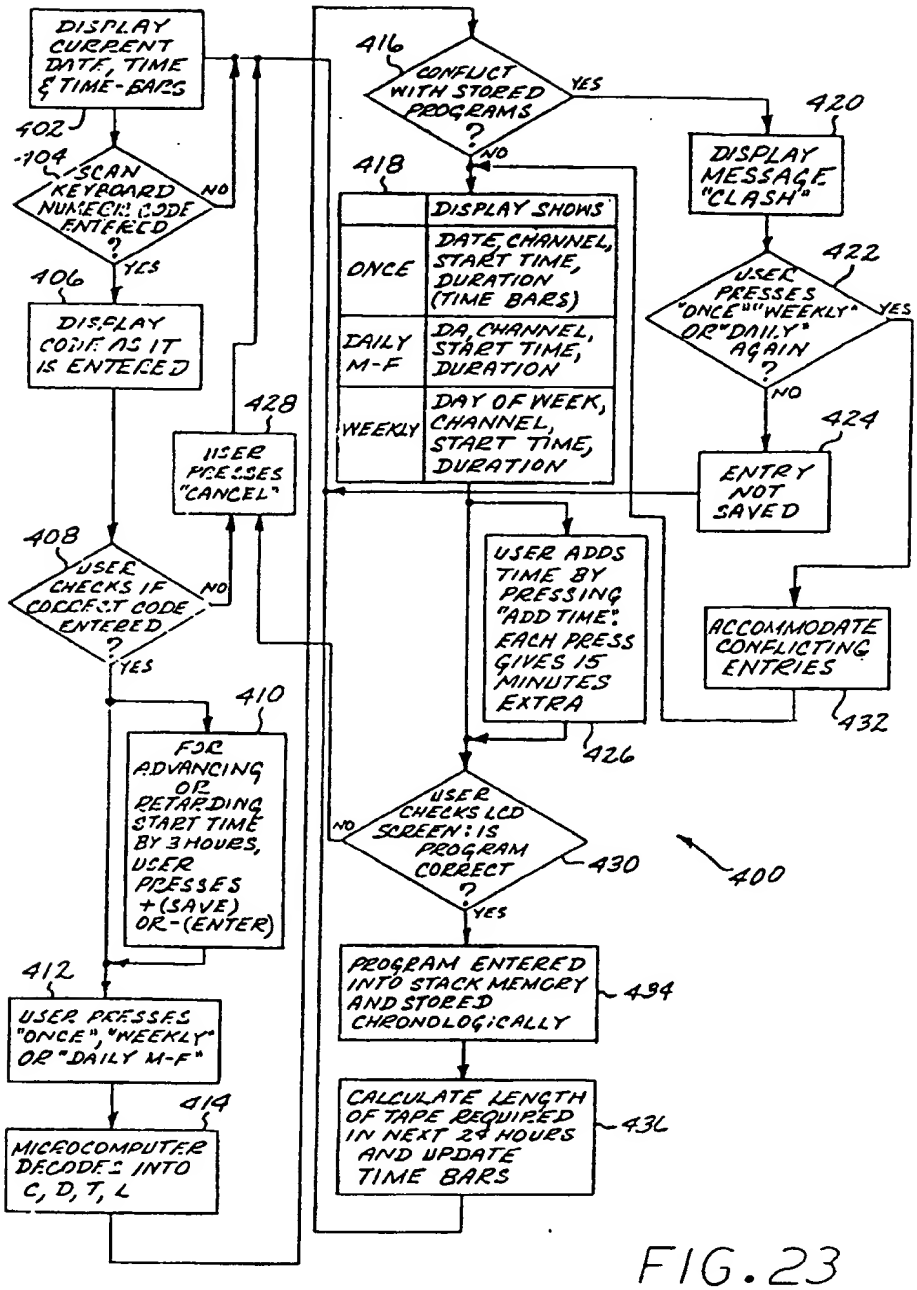


FIG. 23

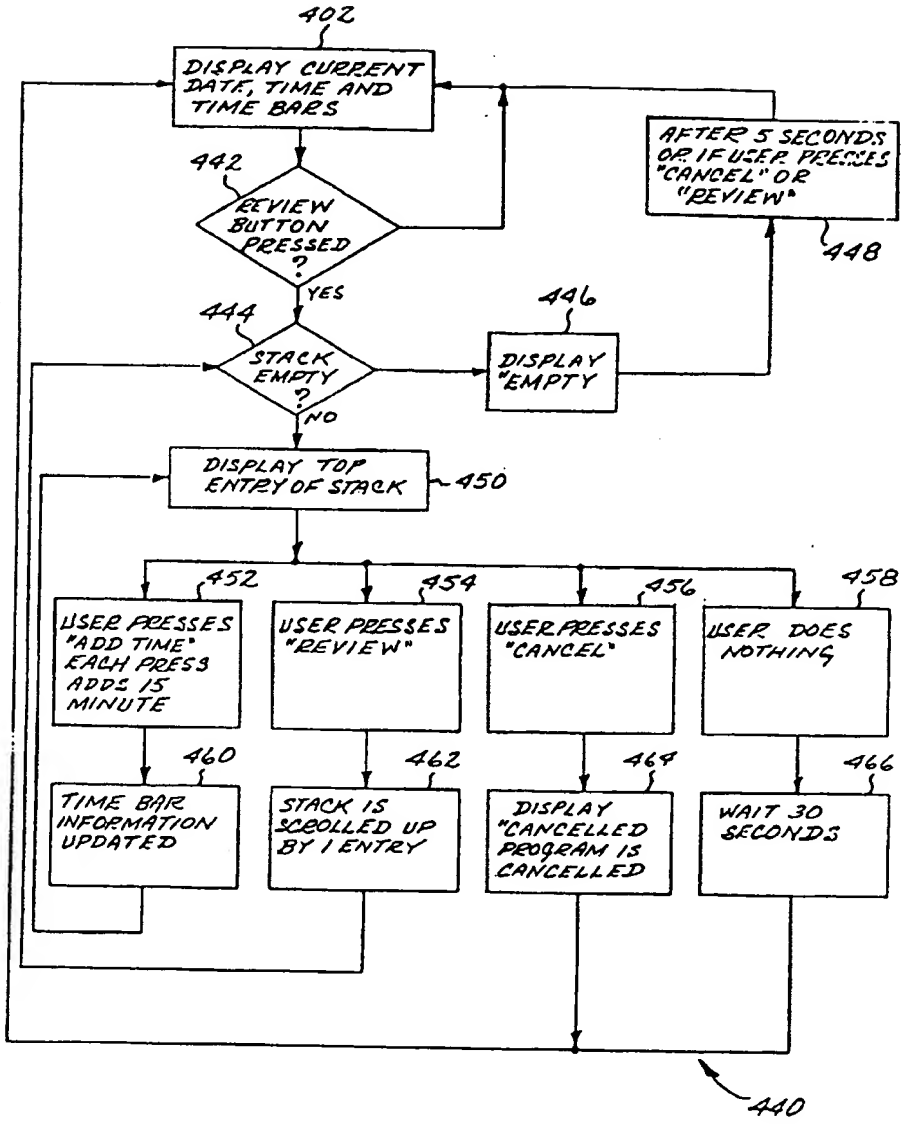


FIG. 24

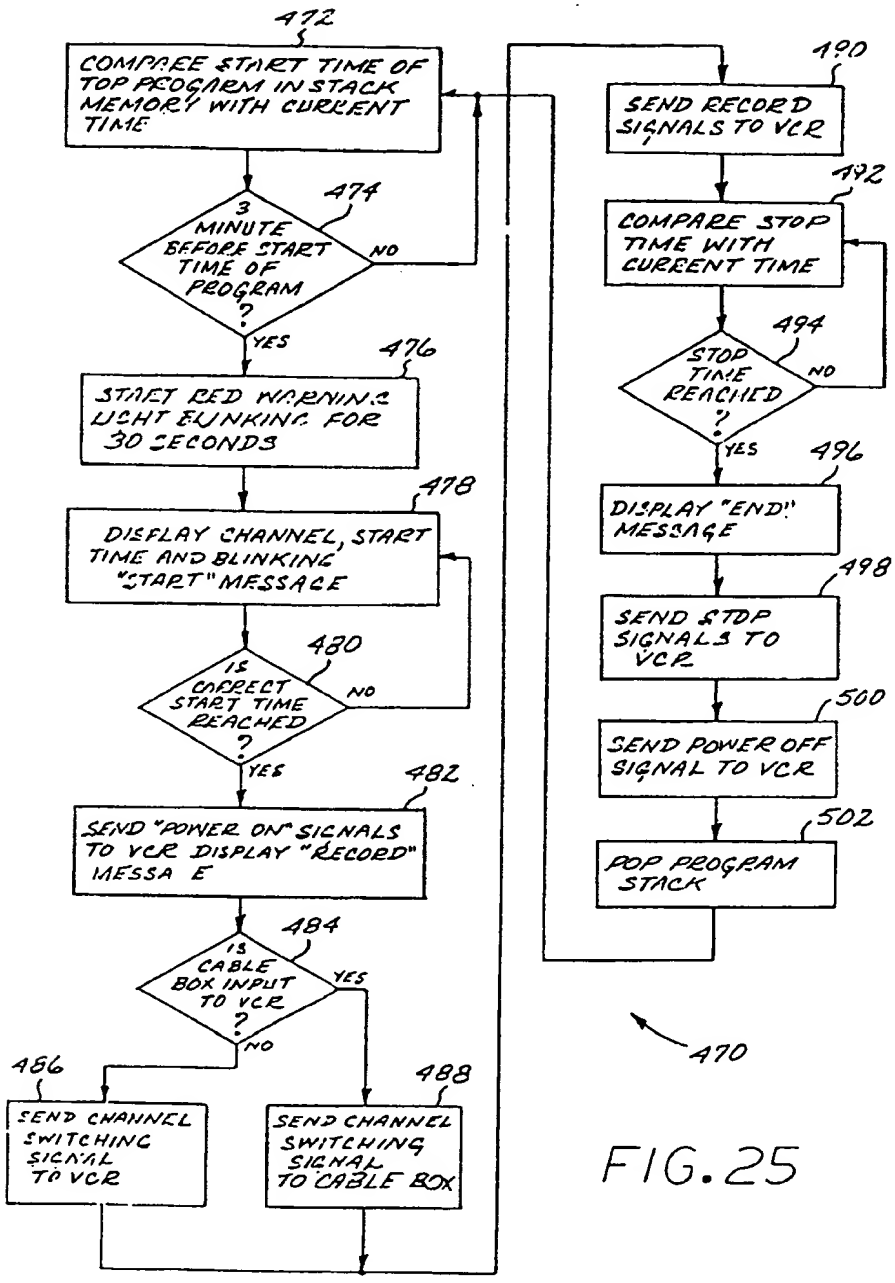

472
COMPARE START TIME OF TOP PROGRAM IN STACK MEMORY WITH CURRENT TIME
474
3 MINUTE BEFORE START TIME OF PROGRAM ?
NO
YES
476
START RED WARNING LIGHT BLINKING FOR 30 SECONDS
478
DISPLAY CHANNEL, START TIME AND BLINKING "START" MESSAGE
480
IS CORRECT START TIME REACHED ?
NO
YES
482
SEND "POWER ON" SIGNALS TO VCR DISPLAY "RECORD" MESSAGE
484
IS CABLE BOX INPUT TO VCR ?
YES
NO
486
SEND CHANNEL SWITCHING SIGNAL TO VCR
488
SEND CHANNEL SWITCHING SIGNAL TO CABLE BOX
490
SEND RECORD SIGNALS TO VCR
492
COMPARE STOP TIME WITH CURRENT TIME
494
STOP TIME REACHED ?
NO
YES
496
DISPLAY "END" MESSAGE
498
SEND STOP SIGNALS TO VCR
500
SEND POWER OFF SIGNAL TO VCR
502
POP PROGRAM STACK
470

FIG. 25

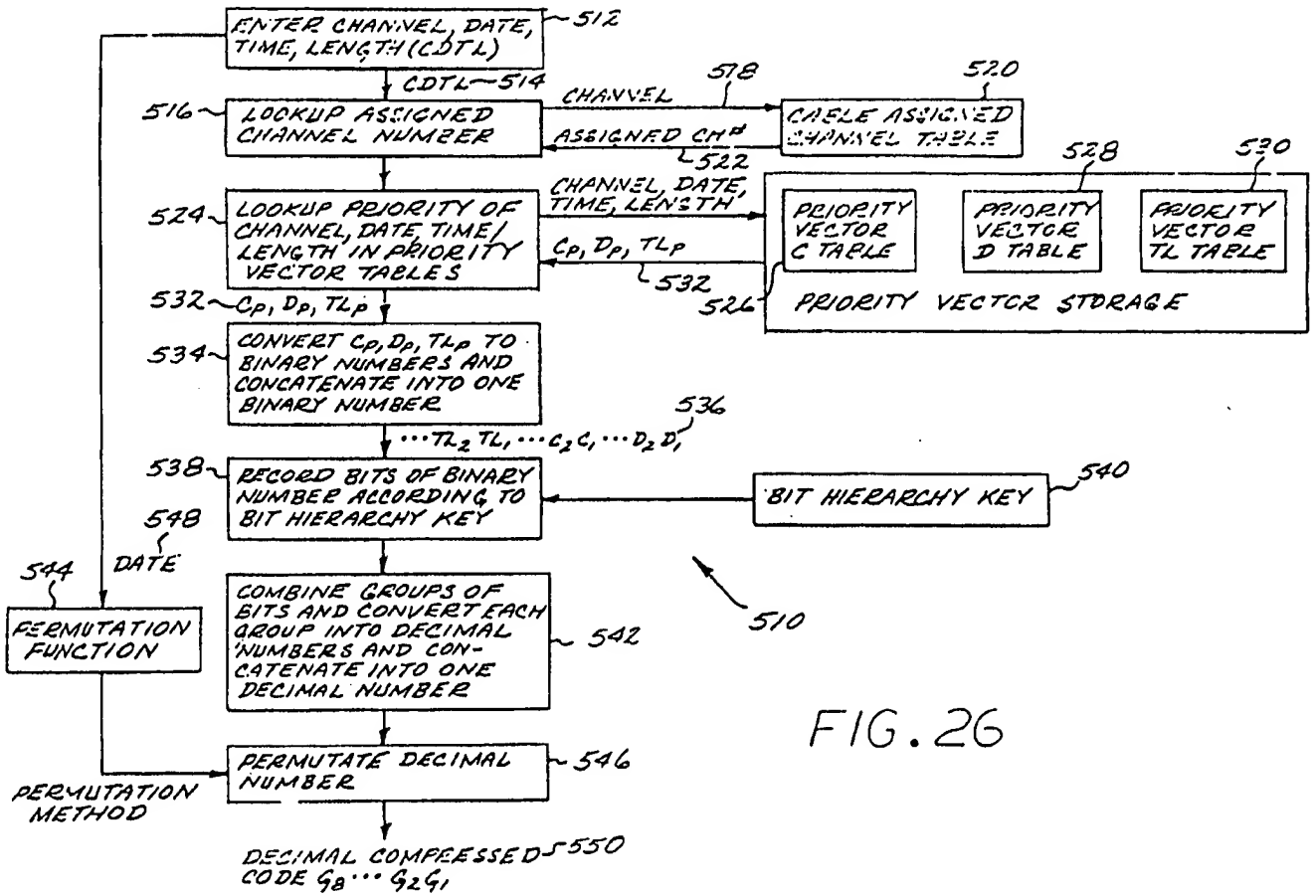

ENTER CHANNEL, DATE, TIME, LENGTH (CDTL)
512
CDTL
514
LOOKUP ASSIGNED CHANNEL NUMBER
516
CHANNEL
518
ASSIGNED CH#
522
CABLE ASSIGNED CHANNEL TABLE
520
LOOKUP PRIORITY OF CHANNEL, DATE TIME/ LENGTH IN PRIORITY VECTOR TABLES
524
CHANNEL, DATE, TIME, LENGTH
Cp, Dp, TLp
532
PRIORITY VECTOR C TABLE
PRIORITY VECTOR D TABLE
PRIORITY VECTOR TL TABLE
528
530
526
PRIORITY VECTOR STORAGE
532 Cp, Dp, TLp
CONVERT Cp, Dp, TLp TO BINARY NUMBERS AND CONCATENATE INTO ONE BINARY NUMBER
534
536
... TL2 TL1 ... C2 C1 ... D2 D1
RECORD BITS OF BINARY NUMBER ACCORDING TO BIT HIERARCHY KEY
538
BIT HIERARCHY KEY
540
548
DATE
544
PERMUTATION FUNCTION
COMBINE GROUPS OF BITS AND CONVERT EACH GROUP INTO DECIMAL NUMBERS AND CONCATENATE INTO ONE DECIMAL NUMBER
542
510
PERMUTATE DECIMAL NUMBER
546
PERMUTATION METHOD
DECIMAL COMPRESSED CODE G8 ... G2 G1
550

FIG. 26

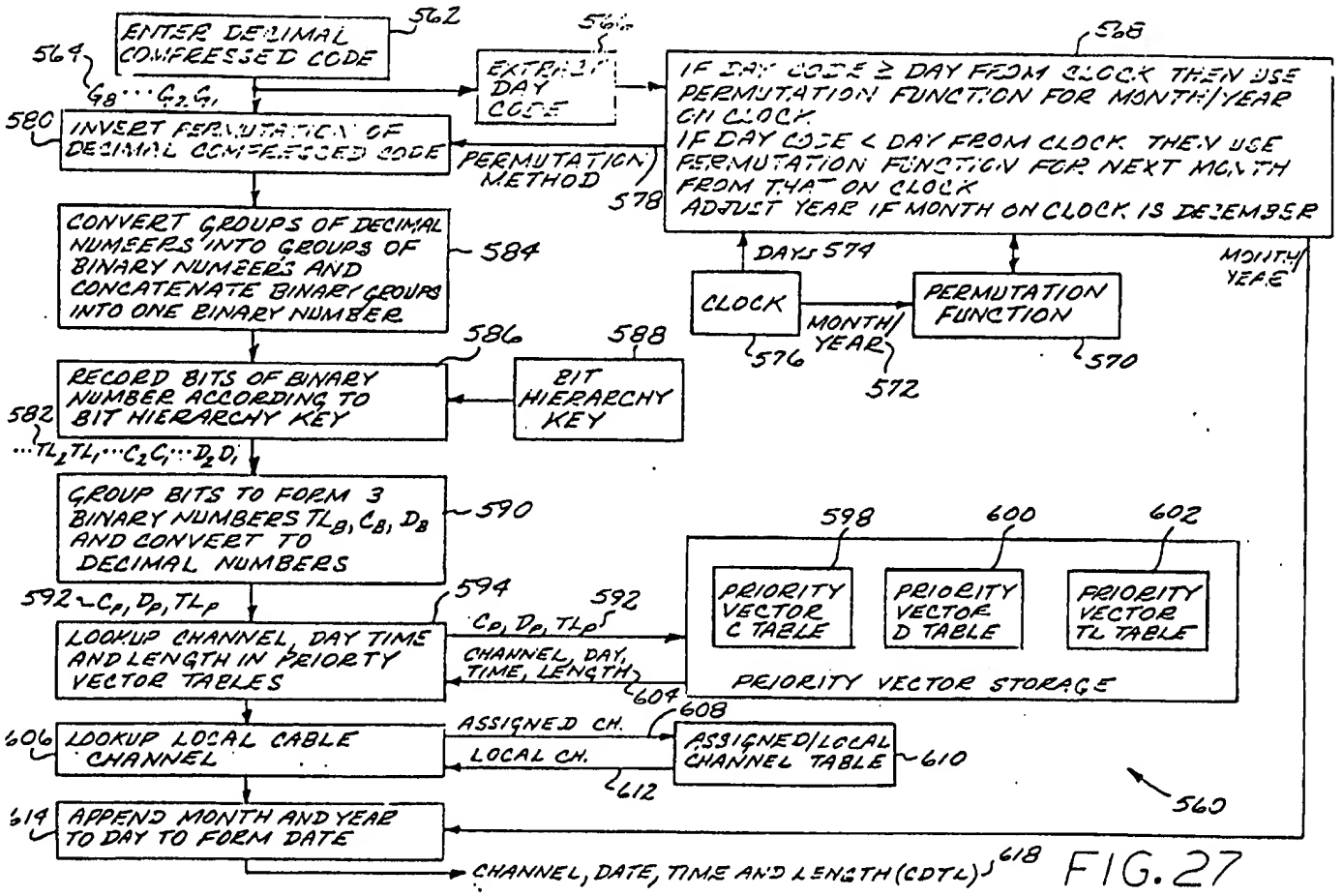
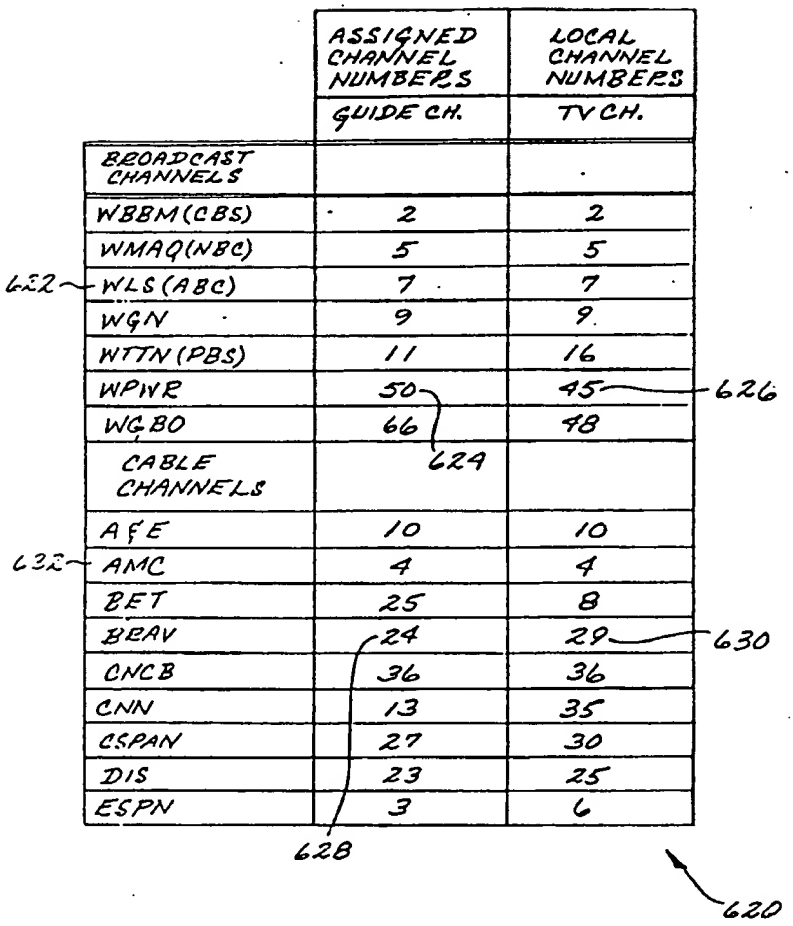

562
ENTER DECIMAL COMPRESSED CODE
564
$G_8 \cdots G_2 G_1$
566
EXTRACT DAY CODE
568
IF DAY CODE ≥ DAY FROM CLOCK THEN USE PERMUTATION FUNCTION FOR MONTH/YEAR ON CLOCK
IF DAY CODE < DAY FROM CLOCK THEN USE PERMUTATION FUNCTION FOR NEXT MONTH FROM THAT ON CLOCK
ADJUST YEAR IF MONTH ON CLOCK IS DECEMBER
580
INVERT PERMUTATION OF DECIMAL COMPRESSED CODE
PERMUTATION METHOD
578
DAYS 574
MONTH/YEAR
CLOCK
576
MONTH/YEAR
572
PERMUTATION FUNCTION
570
584
CONVERT GROUPS OF DECIMAL NUMBERS INTO GROUPS OF BINARY NUMBERS AND CONCATENATE BINARY GROUPS INTO ONE BINARY NUMBER
586
588
RECORD BITS OF BINARY NUMBER ACCORDING TO BIT HIERARCHY KEY
BIT HIERARCHY KEY
582
$\cdots TL_2 TL_1 \cdots C_2 C_1 \cdots D_2 D_1$
590
GROUP BITS TO FORM 3 BINARY NUMBERS TL_B, C_B, D_B AND CONVERT TO DECIMAL NUMBERS
598
600
602
PRIORITY VECTOR C TABLE
PRIORITY VECTOR D TABLE
PRIORITY VECTOR TL TABLE
PRIORITY VECTOR STORAGE
592
C_P, D_P, TL_P
594
592
C_P, D_P, TL_P
LOOKUP CHANNEL, DAY TIME AND LENGTH IN PRIORTY VECTOR TABLES
CHANNEL, DAY, TIME, LENGTH
604
608
ASSIGNED CH.
606
LOOKUP LOCAL CABLE CHANNEL
LOCAL CH.
612
ASSIGNED/LOCAL CHANNEL TABLE
610
560
614
APPEND MONTH AND YEAR TO DAY TO FORM DATE
CHANNEL, DATE, TIME AND LENGTH (CDTL)
618

FIG. 27



	ASSIGNED CHANNEL NUMBERS	LOCAL CHANNEL NUMBERS
	GUIDE CH.	TV CH.
BROADCAST CHANNELS		
WBBM (CBS)	2	2
WMAQ (NBC)	5	5
622 ~ WLS (ABC)	7	7
WGN	9	9
WTTN (PBS)	11	16
WPWR	50	45 — 626
WGBO	66 — 624	48
CABLE CHANNELS		
AFE	10	10
632 ~ AMC	4	4
BET	25	8
BRAV	24	29 — 630
CNCB	36	36
CNN	13	35
CSPAN	27	30
DIS	23	25
ESPN	3	6

628

620

FIG. 28

FIG. 29

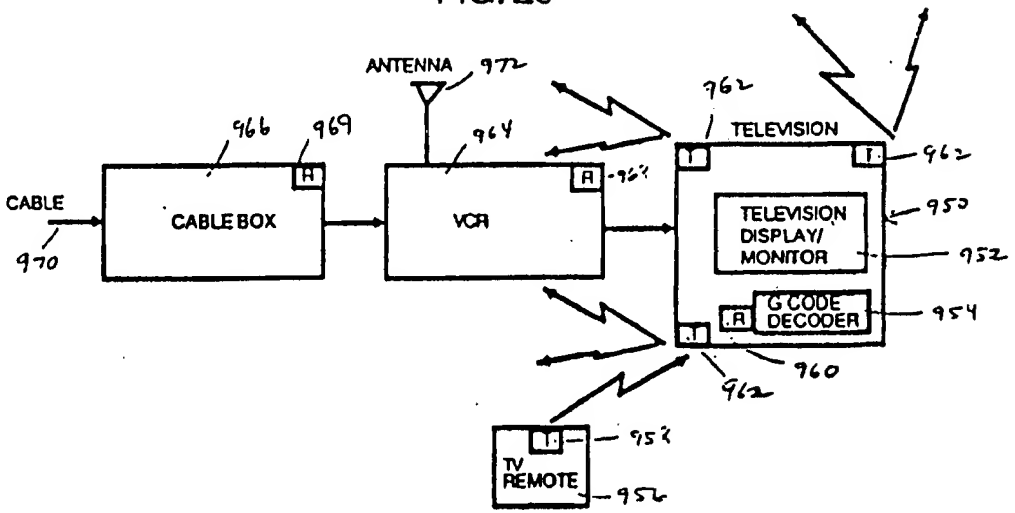

ANTENNA
972
962
TELEVISION
966
969
964
CABLE
CABLE BOX
VCR
970
962
TELEVISION DISPLAY/ MONITOR
950
952
G CODE DECODER
954
960
962
TV REMOTE
958
956

FIG. 30

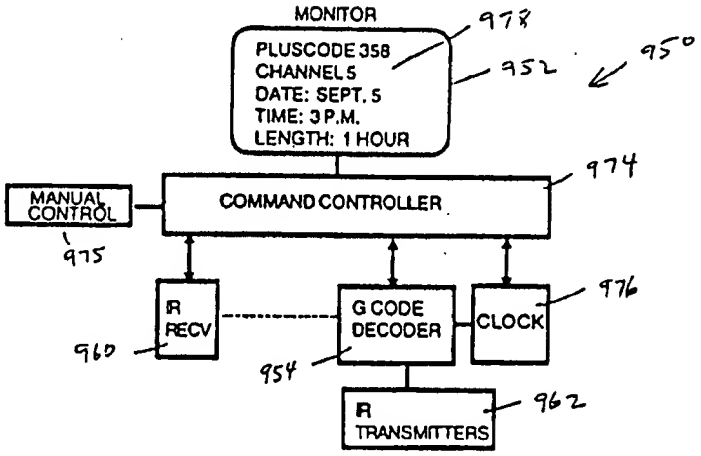

MONITOR
978
PLUSCODE 358
CHANNEL 5
DATE: SEPT. 5
TIME: 3 P.M.
LENGTH: 1 HOUR
952
950
974
MANUAL CONTROL
975
COMMAND CONTROLLER
IR RECV
960
G CODE DECODER
954
CLOCK
976
IR TRANSMITTERS
962

FIG. 31

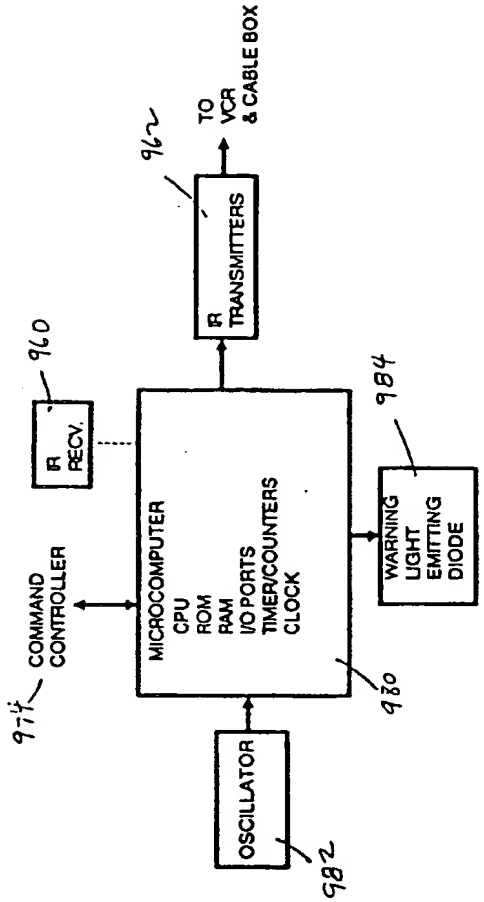

960
962
TO VCR & CABLE BOX
IR RECV.
IR TRANSMITTERS
COMMAND CONTROLLER
MICROCOMPUTER
CPU
ROM
RAM
I/O PORTS
TIMER/COUNTERS
CLOCK
WARNING LIGHT EMITTING DIODE
984
980
OSCILLATOR
982

FIG. 32

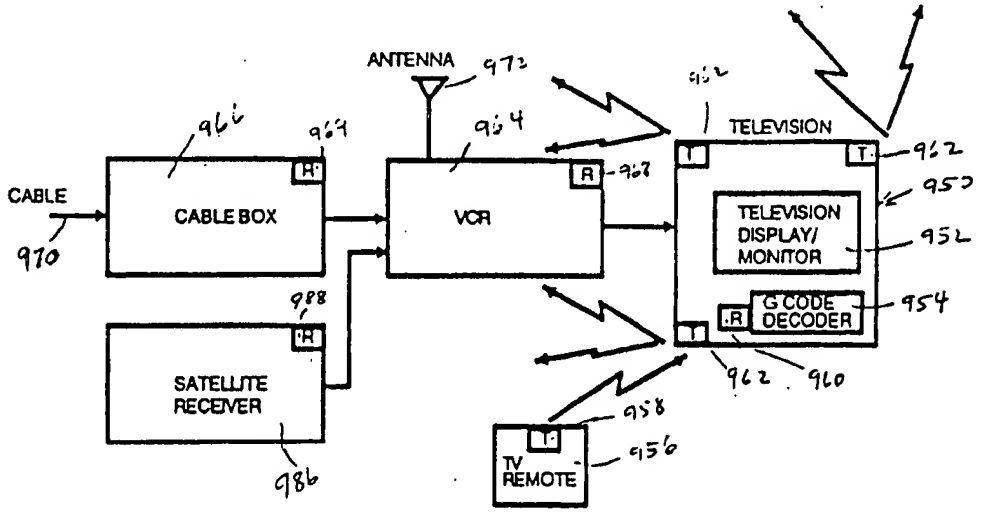

ANTENNA
TELEVISION
CABLE
CABLE BOX
VCR
TELEVISION DISPLAY/ MONITOR
G CODE DECODER
SATELLITE RECEIVER
TV REMOTE
T
R

FIG. 33

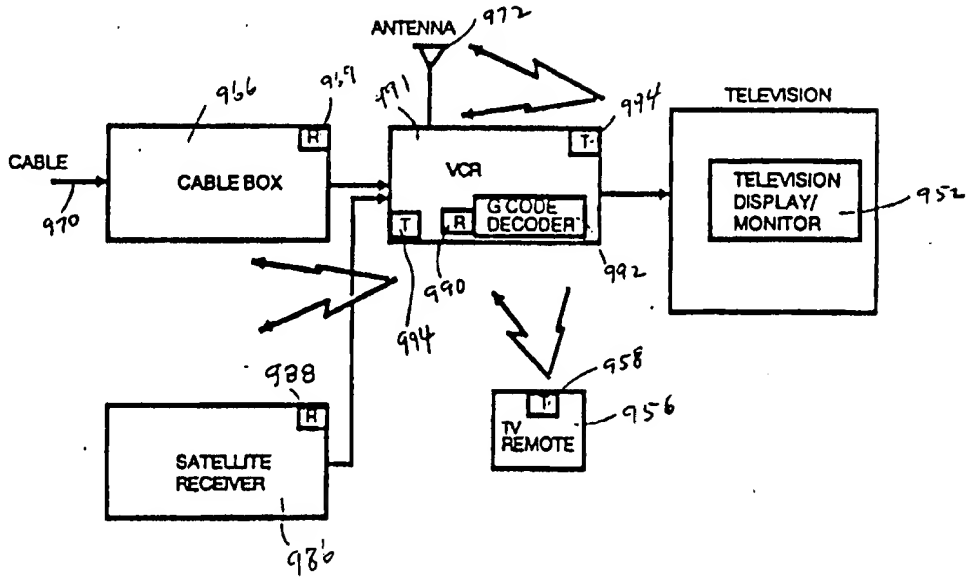

ANTENNA
972
966
969
971
974
TELEVISION
CABLE
CABLE BOX
VCR
G-CODE DECODER
TELEVISION DISPLAY/ MONITOR
952
970
990
992
994
988
958
956
TV REMOTE
SATELLITE RECEIVER
980

FIG. 34

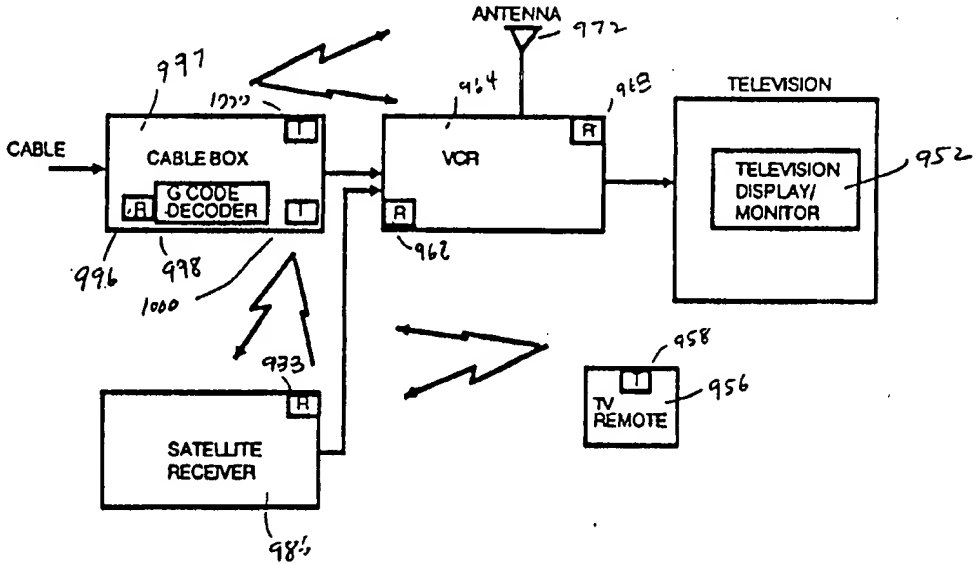
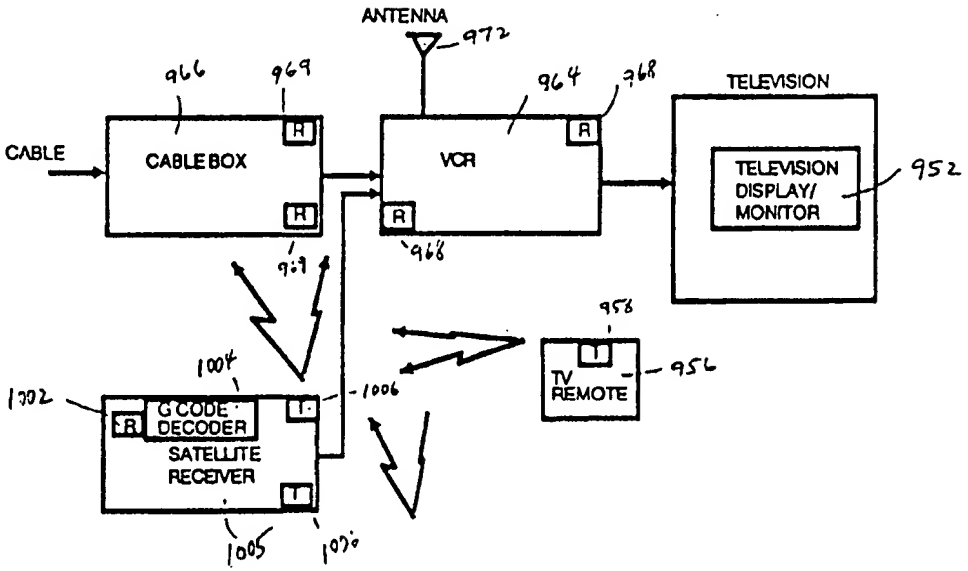

ANTENNA
972
997
1000
964
968
TELEVISION
CABLE
CABLE BOX
G CODE DECODER
VCR
TELEVISION DISPLAY/ MONITOR
952
996
998
962
933
958
956
TV REMOTE
SATELLITE RECEIVER
984

FIG. 35


ANTENNA
972
966
969
964
968
TELEVISION
CABLE
CABLE BOX
VCR
TELEVISION DISPLAY/ MONITOR
952
967
968
958
956
TV REMOTE
1004
1006
1002
G CODE DECODER
SATELLITE RECEIVER
1005
1010

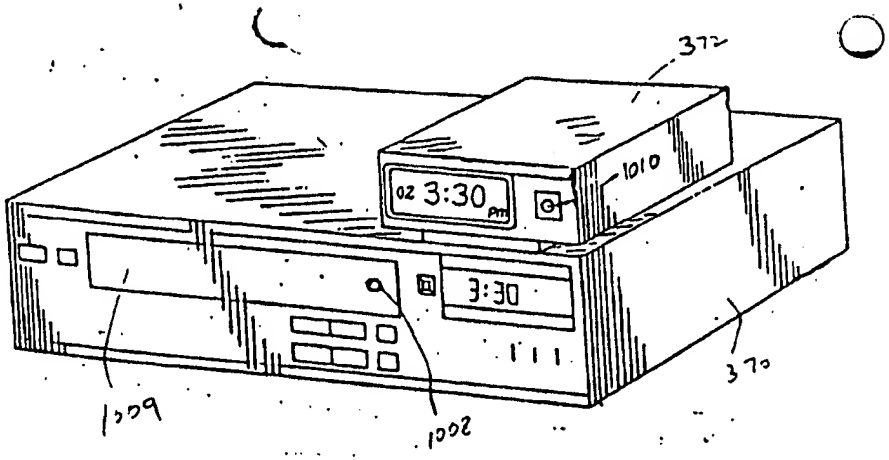

372
1010
02 3:30 PM
3:30
1009
1002
370

FIG. 36

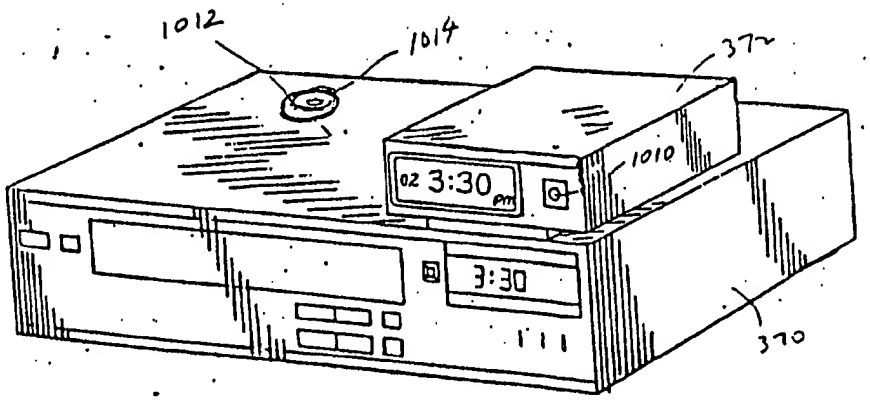

1012
1014
372
1010
02 3:30 PM
3:30
370

FIG. 37

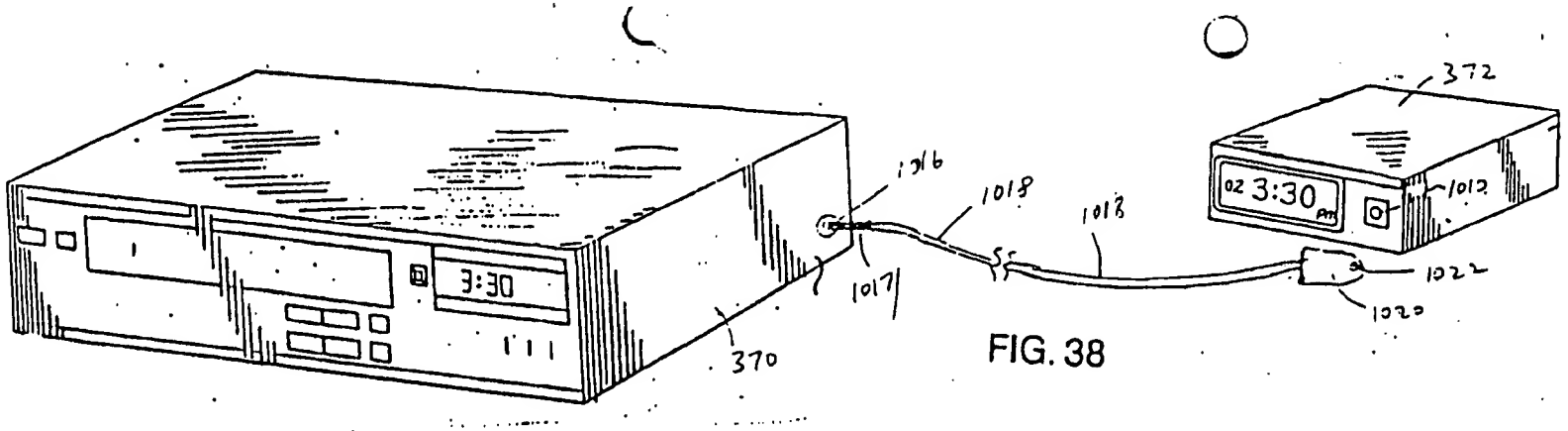

3:30
02 3:30 PM
372
1016
1018
1018
1012
1017
1022
1020
370

FIG. 38

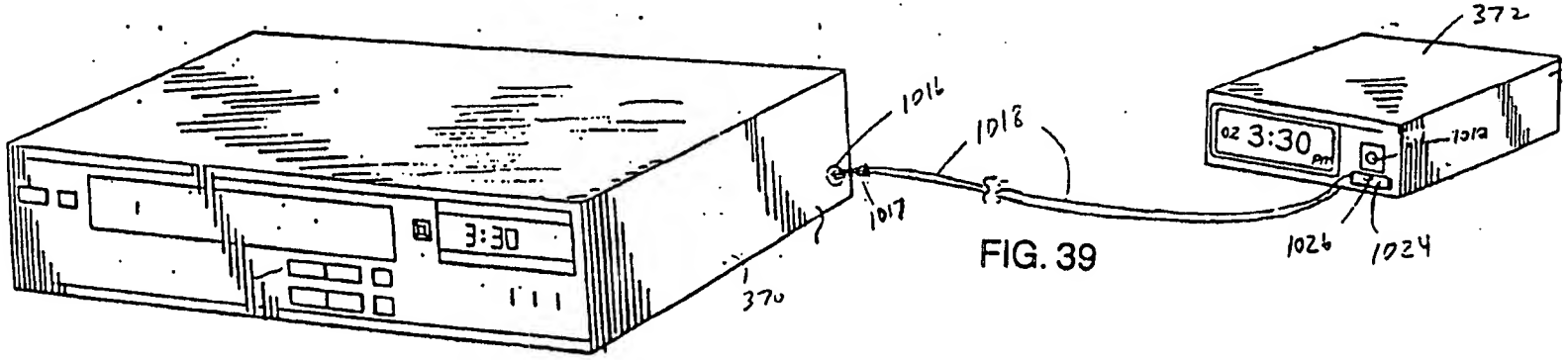

3:30
02 3:30 PM
372
1016
1018
1012
1017
1026
1024
370

FIG. 39

Fig. 40

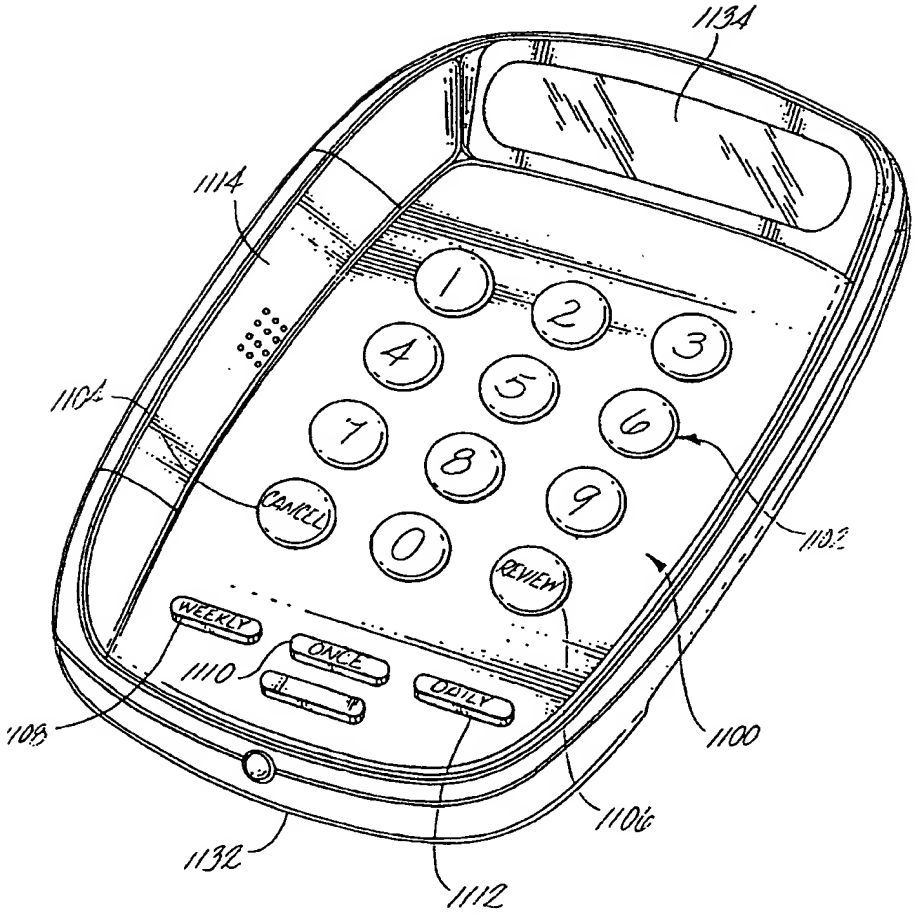

1134
1114
1104
1102
1100
1106
1112
1132
1108
1110
1
2
3
4
5
6
7
8
9
0
CANCEL
REVIEW
WEEKLY
ONCE
DAILY

Fig. 41

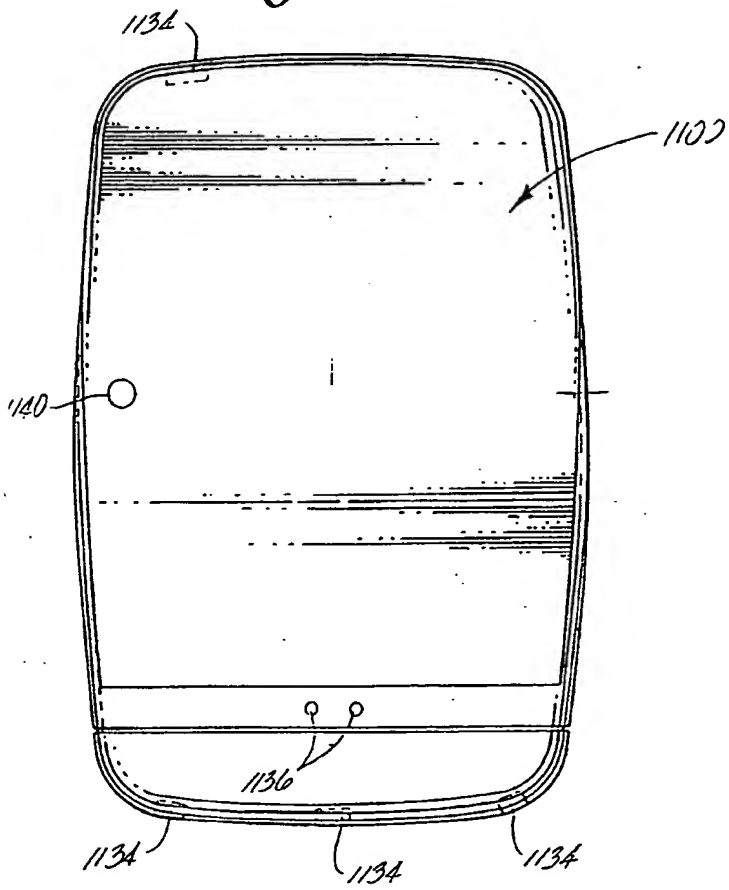


Fig. 42

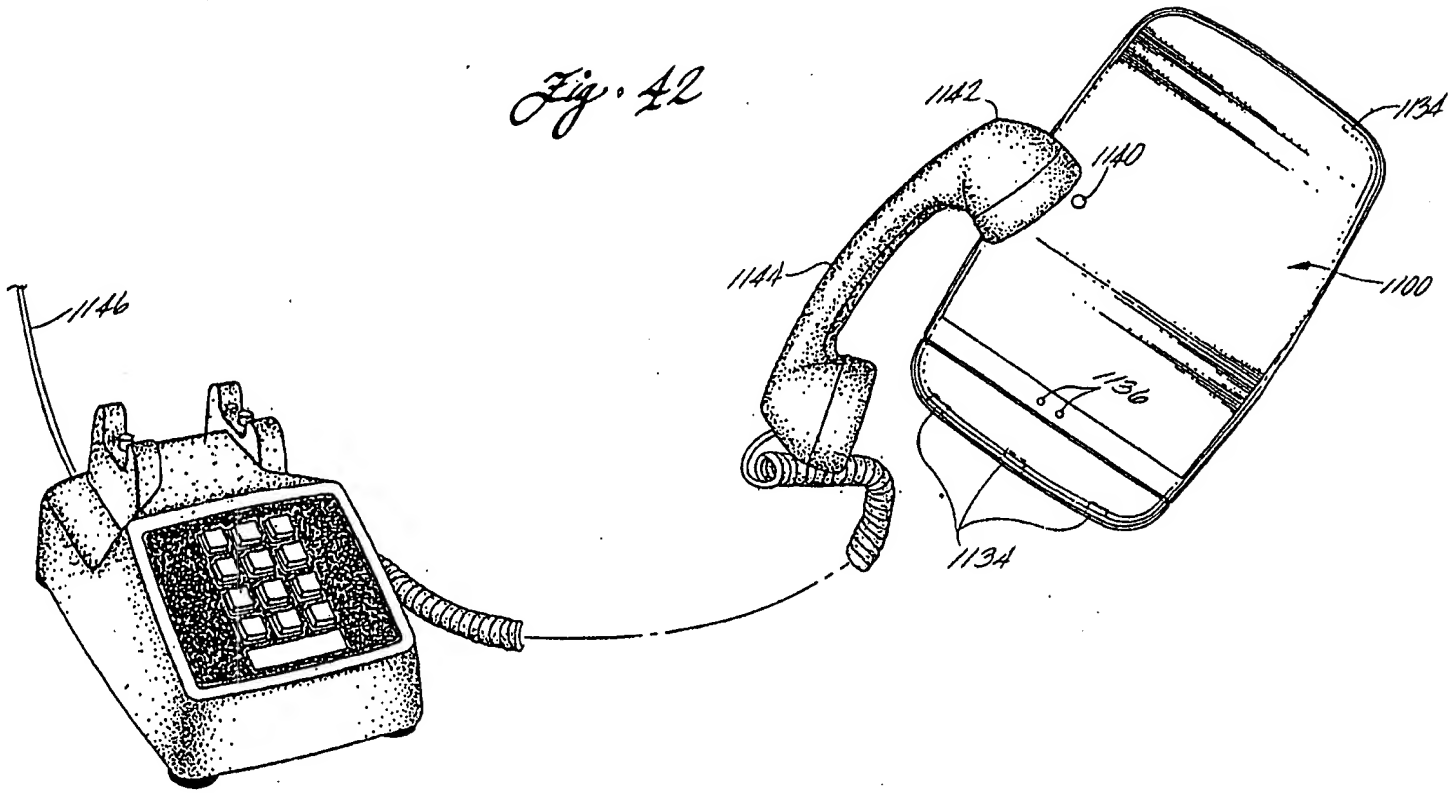


Fig. 43

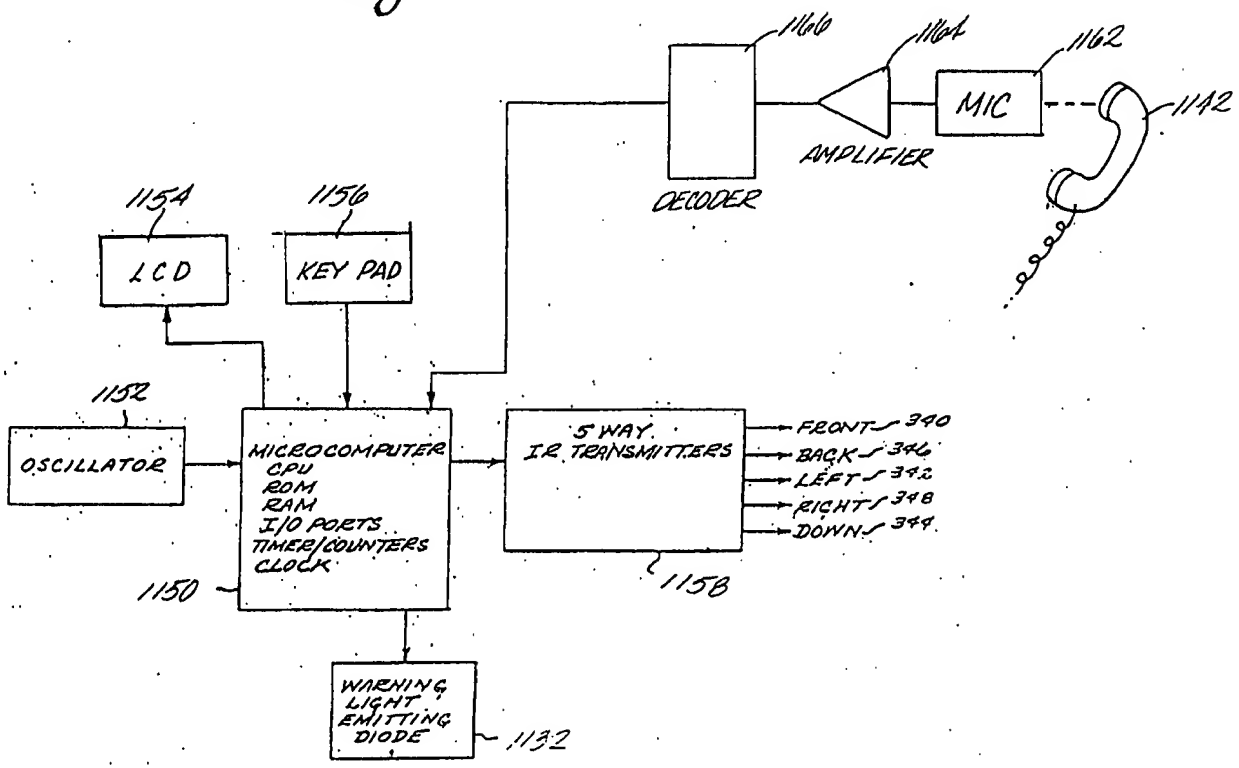

1166
1164
1162
1142
MIC
AMPLIFIER
DECODER
1154
1156
LCD
KEY PAD
1152
OSCILLATOR
MICROCOMPUTER
CPU
ROM
RAM
I/O PORTS
TIMER/COUNTERS
CLOCK
1150
5 WAY
I.R. TRANSMITTERS
1158
FRONT 340
BACK 346
LEFT 342
RIGHT 348
DOWN 349
WARNING LIGHT EMITTING DIODE
1132

Fig. 44

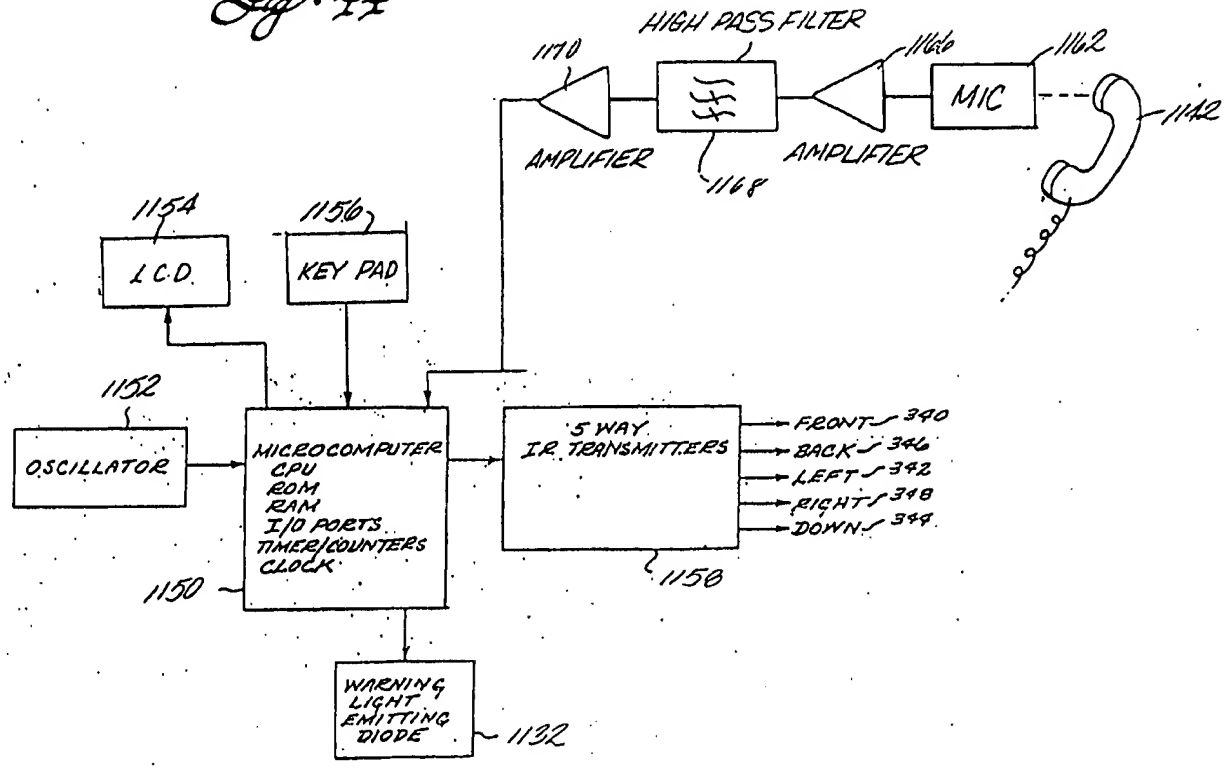

HIGH PASS FILTER
1170
1166
1162
MIC
1142
AMPLIFIER
1168
AMPLIFIER
1154
1156
L.C.D.
KEY PAD
1152
OSCILLATOR
MICROCOMPUTER
CPU
ROM
RAM
I/O PORTS
TIMER/COUNTERS
CLOCK
1150
5 WAY
I.R. TRANSMITTERS
1158
FRONT 340
BACK 346
LEFT 342
RIGHT 348
DOWN 344
WARNING
LIGHT
EMITTING
DIODE
1132

Fig. 45

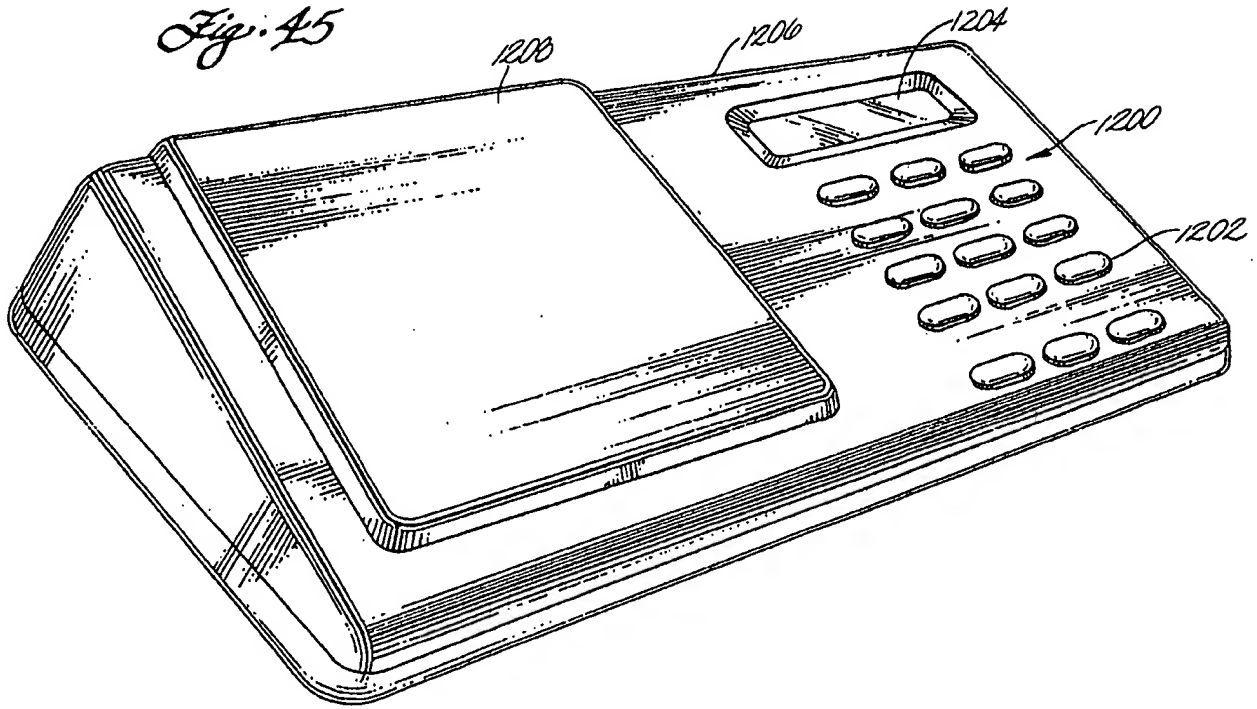


Fig. 46

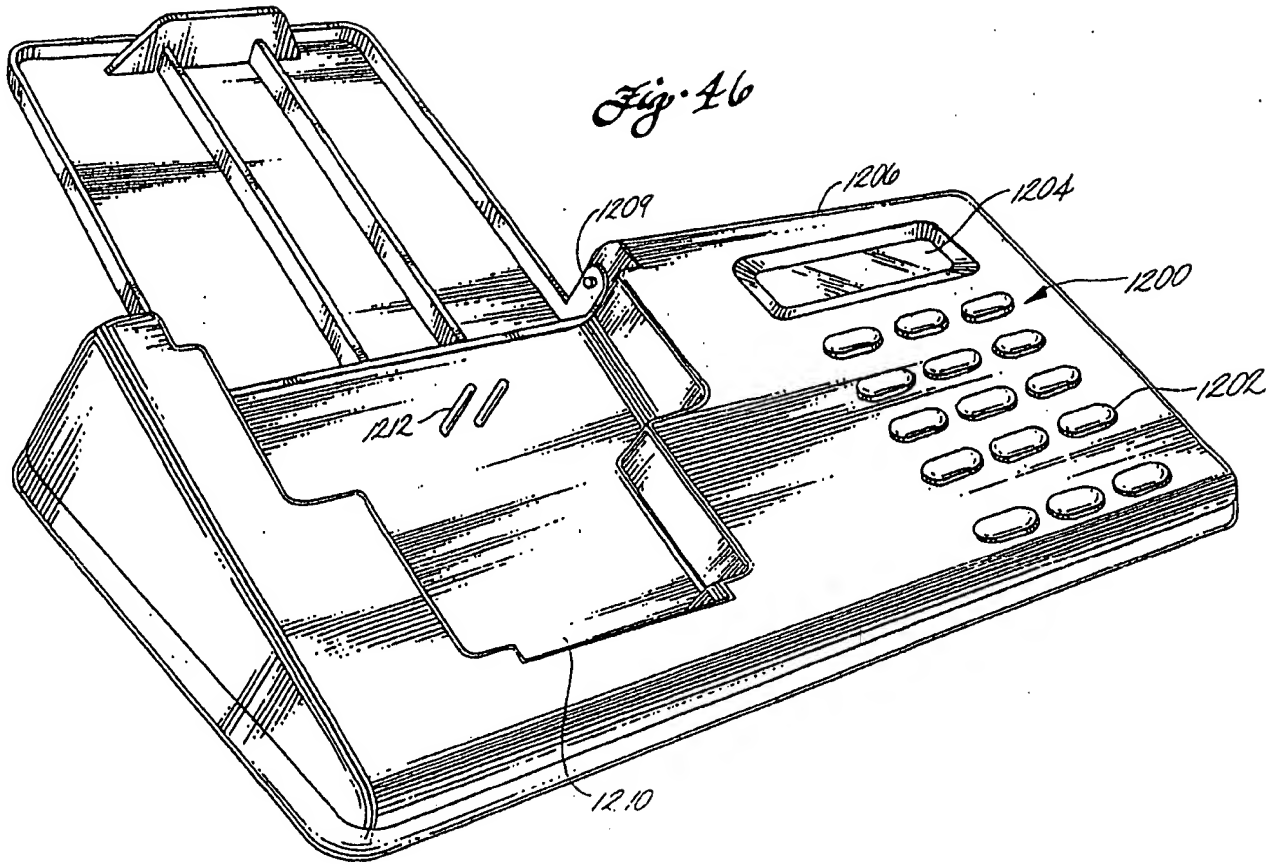


Fig. 47

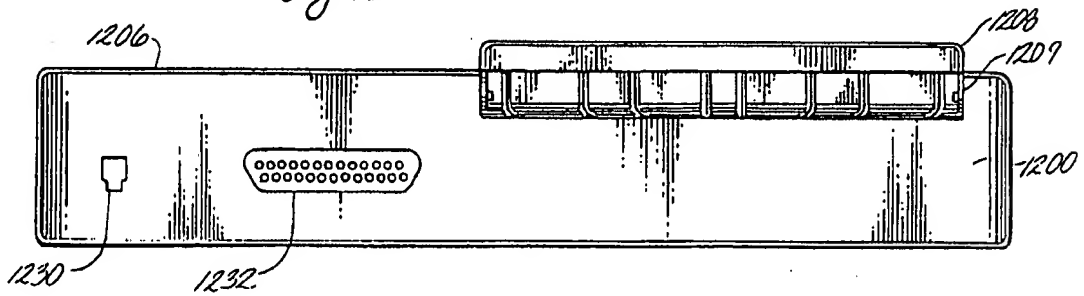
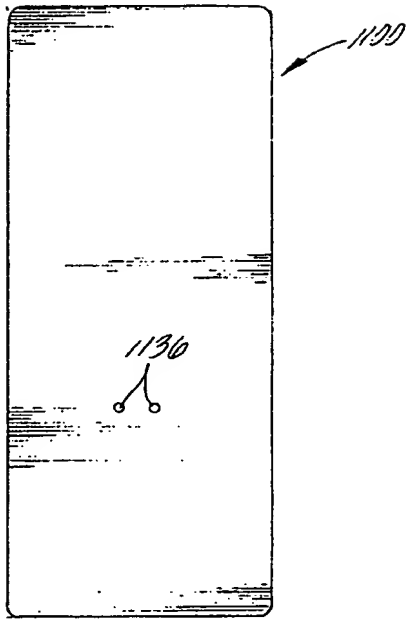


Fig. 40



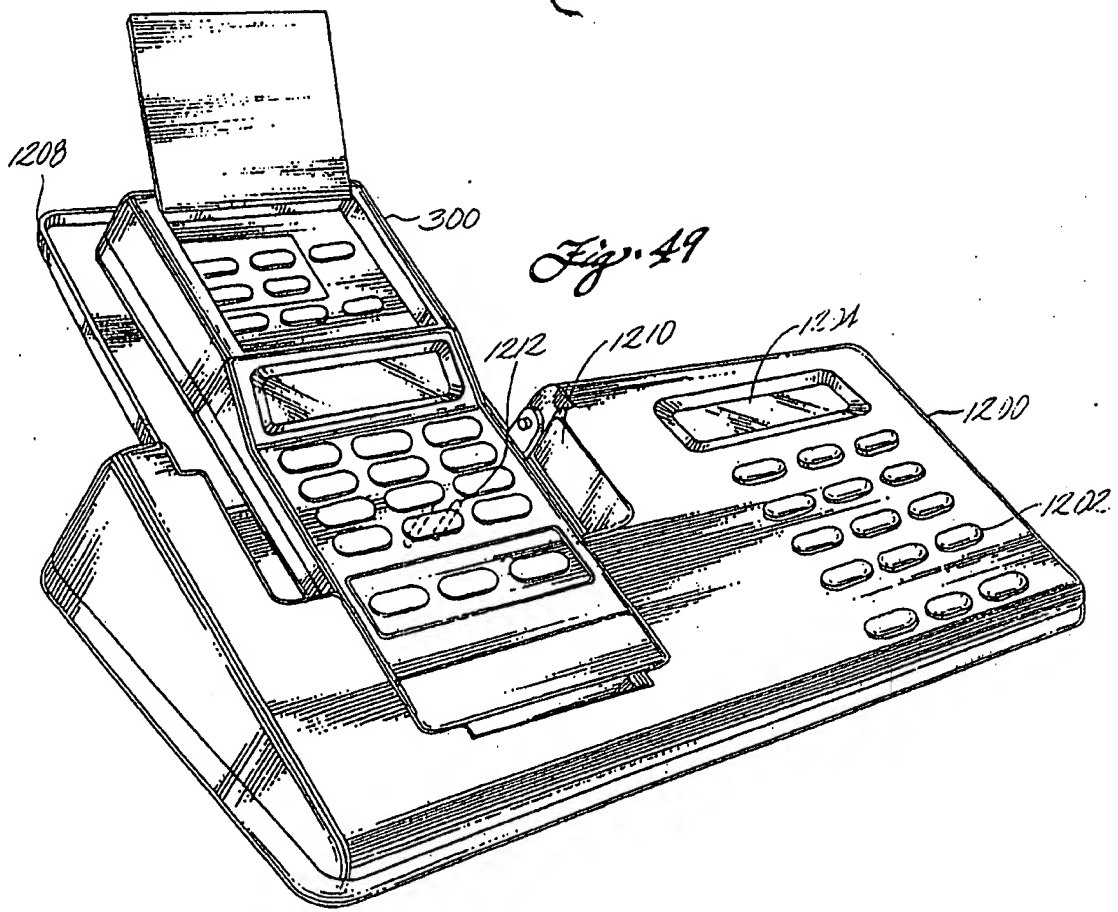


Fig. 49

Fig. 50

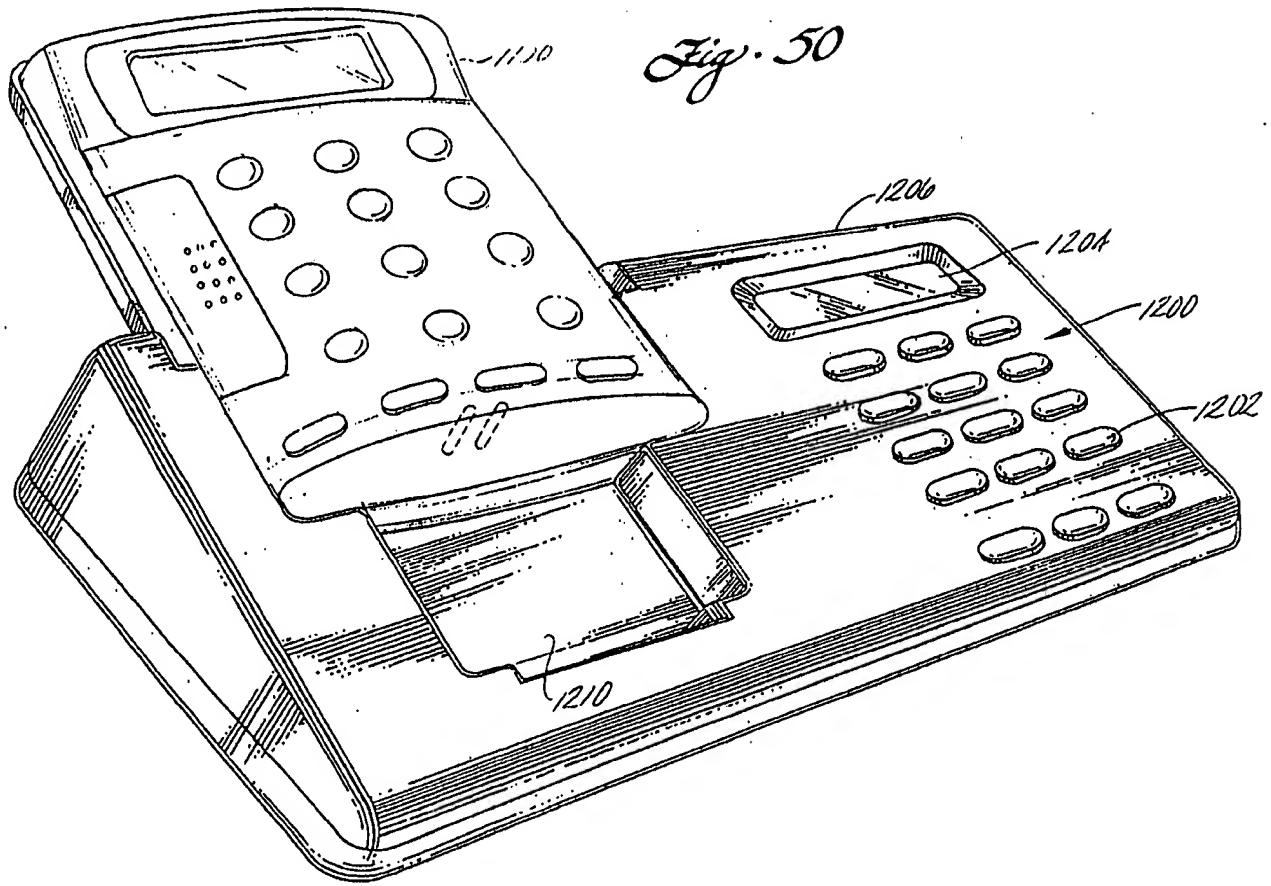


Fig. 51

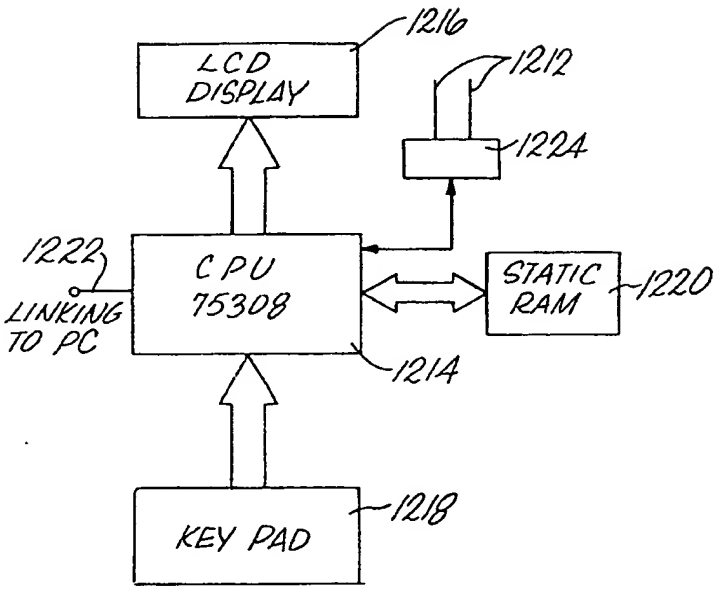
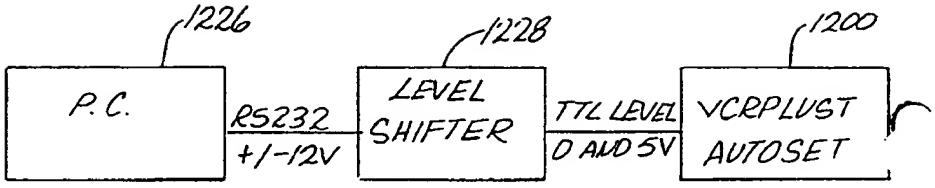

1216
LCD DISPLAY
1212
1224
1222
LINKING TO PC
CPU 75308
STATIC RAM
1220
1214
KEY PAD
1218

Fig. 52


1226
P.C.
RS232
+/-12V
1228
LEVEL
SHIFTER
TTL LEVEL
0 AND 5V
1200
VCRPLUST
AUTOSET

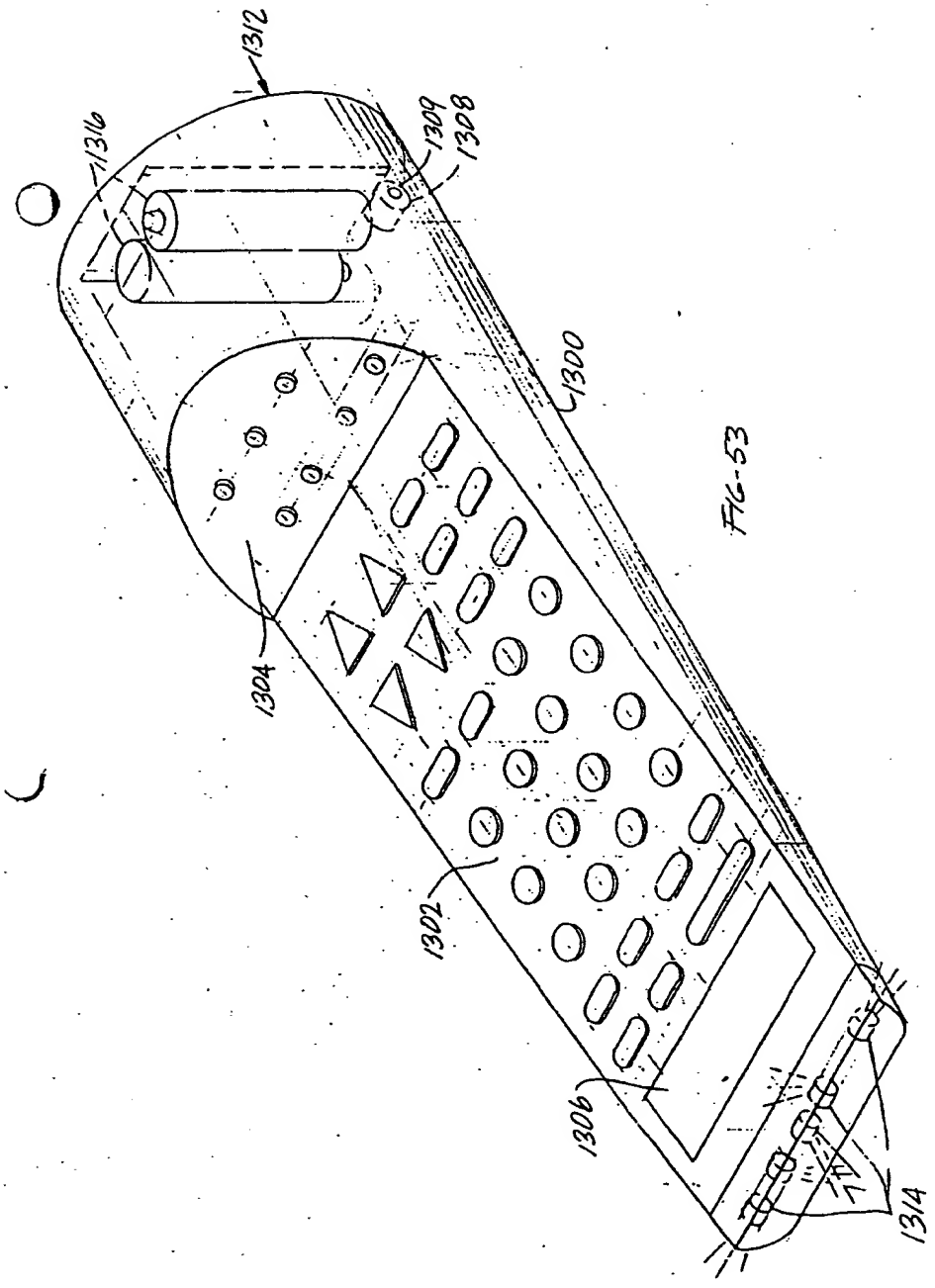


FIG-53

FIG-54

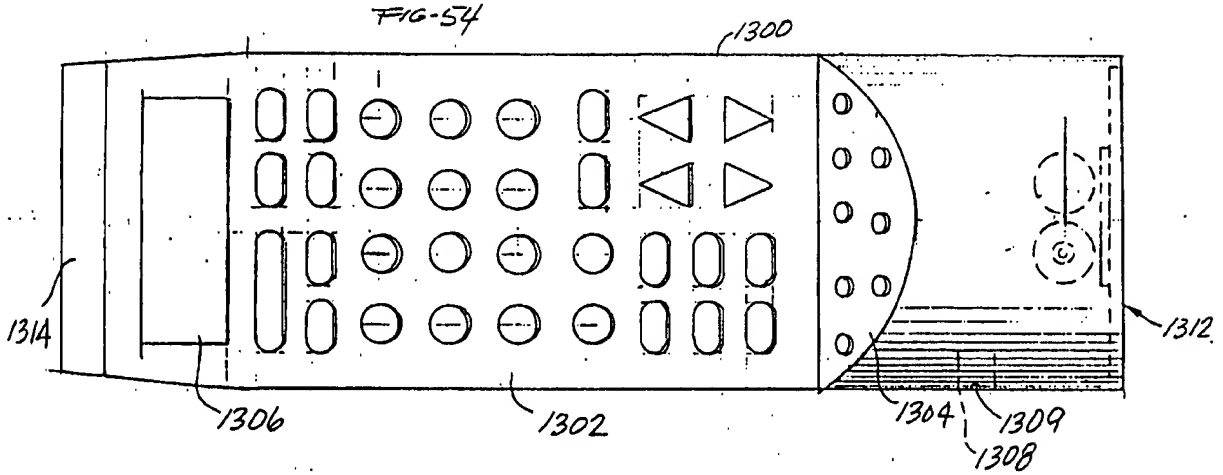
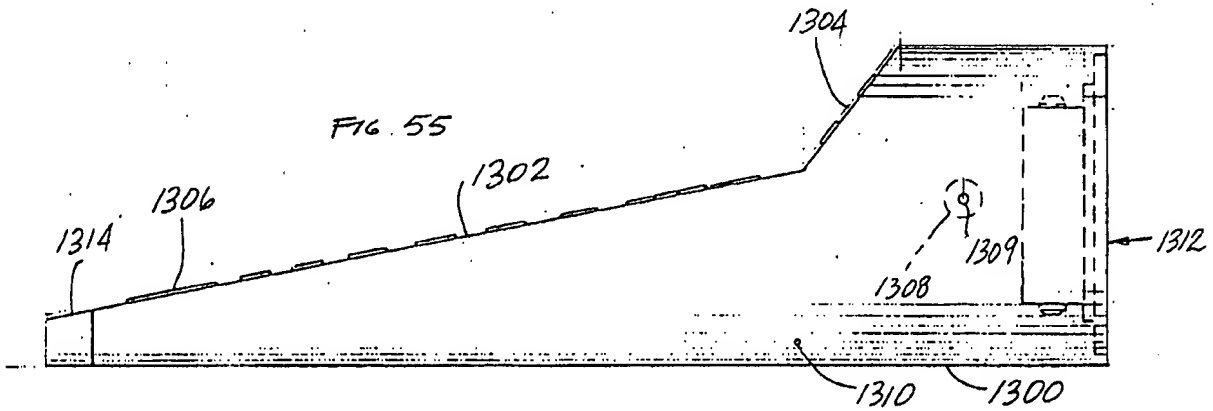

1300
1314
1306
1302
1304
1309
1308
1312

FIG. 55


1304
1306
1302
1314
1309
1312
1308
1310
1300

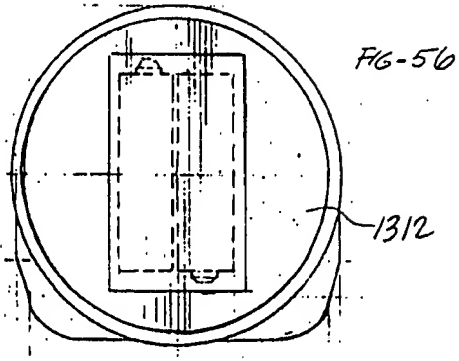


FIG-56

FIG-57

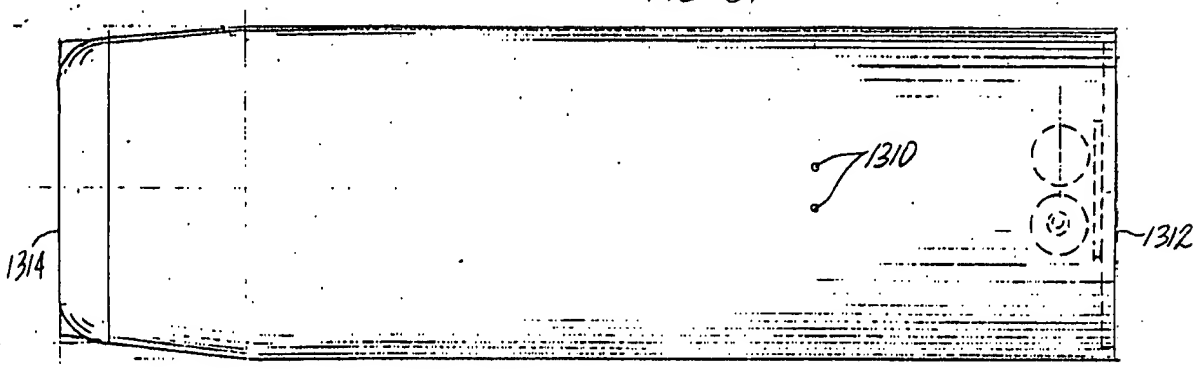


FIG-58

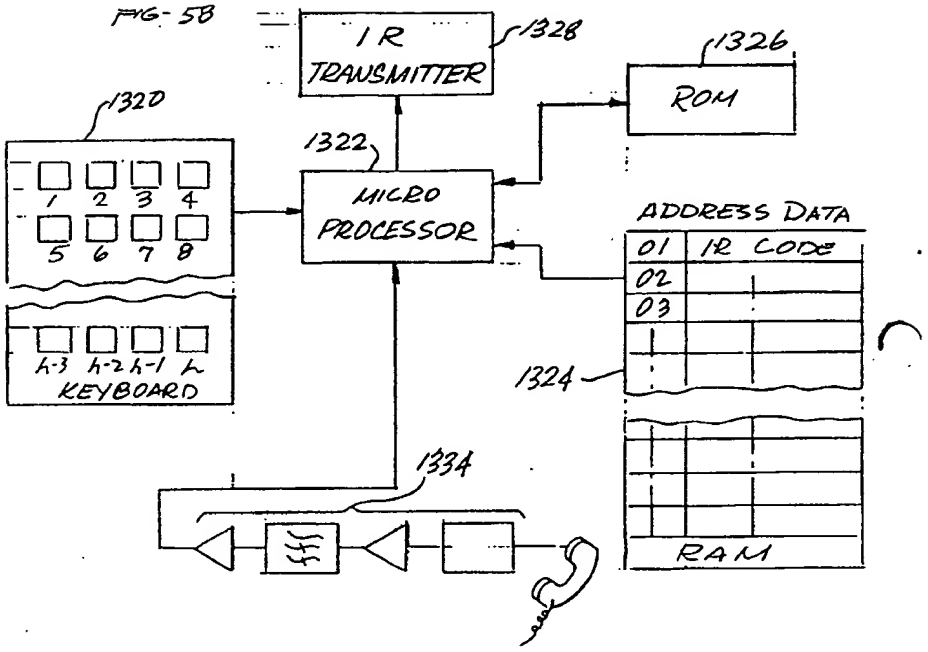
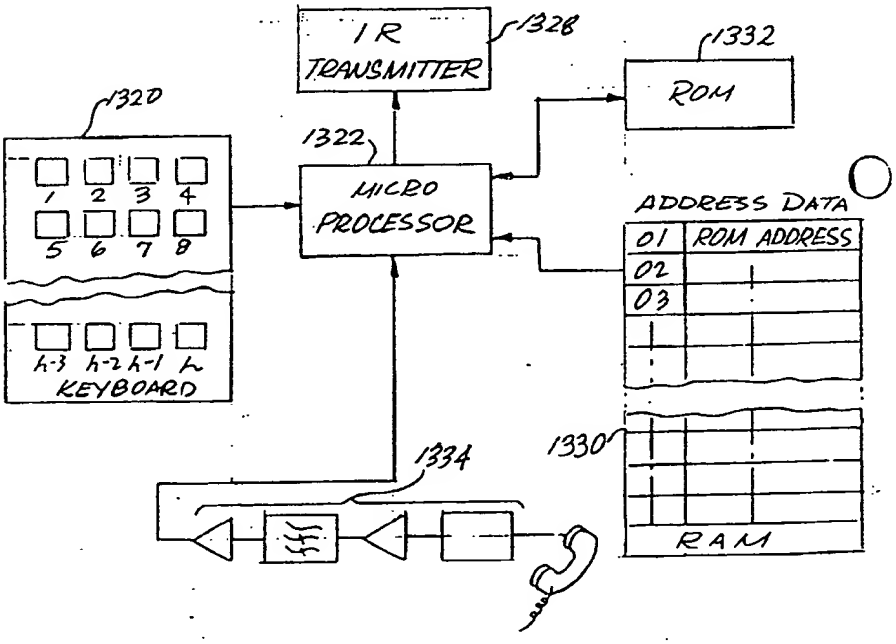

IR TRANSMITTER
1328
1326
ROM
1320
1322
MICRO PROCESSOR
1 2 3 4
5 6 7 8
h-3 h-2 h-1 h
KEYBOARD
ADDRESS DATA
01 IR CODE
02
03
1324
1334
RAM

FIG-59


IR TRANSMITTER
1328
1332
ROM
1320
1322
MICRO PROCESSOR
1 2 3 4
5 6 7 8
h-3 h-2 h-1 h
KEYBOARD
ADDRESS DATA
01 ROM ADDRESS
02
03
1330
1334
RAM

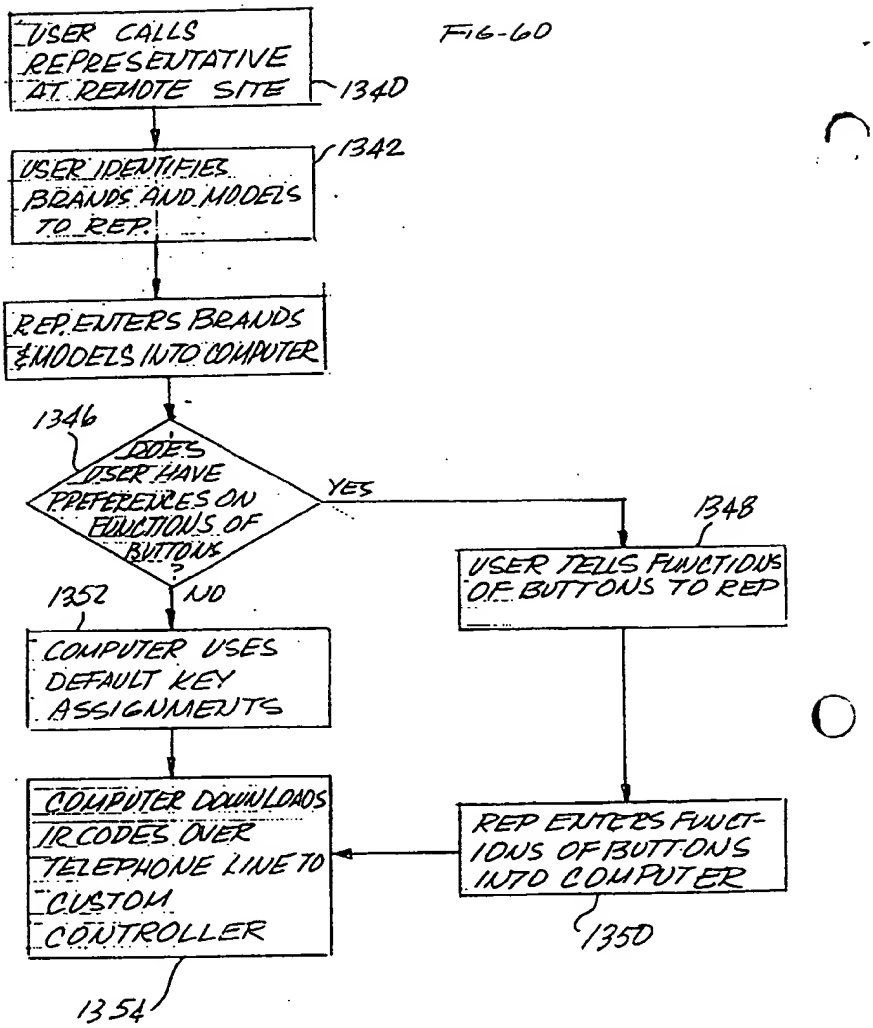

USER CALLS REPRESENTATIVE AT REMOTE SITE
1340
USER IDENTIFIES BRANDS AND MODELS TO REP
1342
REP ENTERS BRANDS & MODELS INTO COMPUTER
1346
DOES USER HAVE PREFERENCES ON FUNCTIONS OF BUTTONS ?
YES
NO
1348
USER TELLS FUNCTIONS OF BUTTONS TO REP
1352
COMPUTER USES DEFAULT KEY ASSIGNMENTS
COMPUTER DOWNLOADS IR CODES OVER TELEPHONE LINE TO CUSTOM CONTROLLER
1354
REP ENTERS FUNCTIONS OF BUTTONS INTO COMPUTER
1350

FIG-60

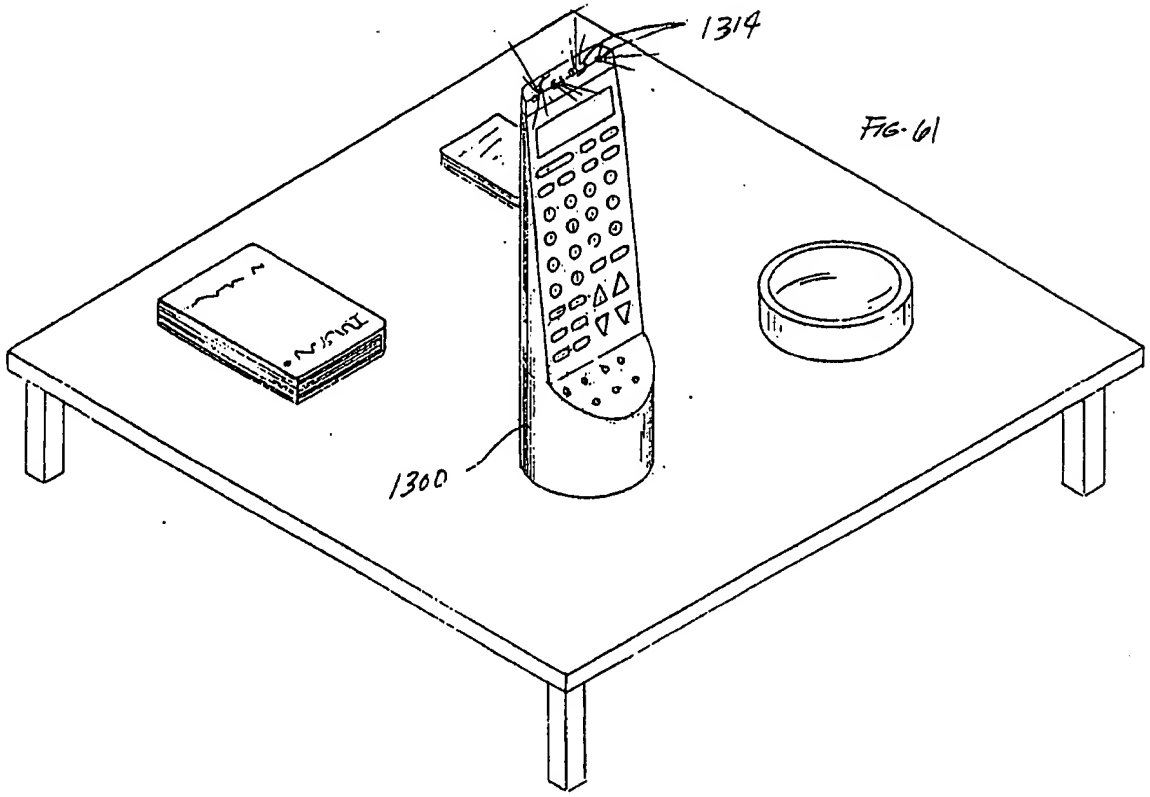


FIG. 61

FIG-7 62

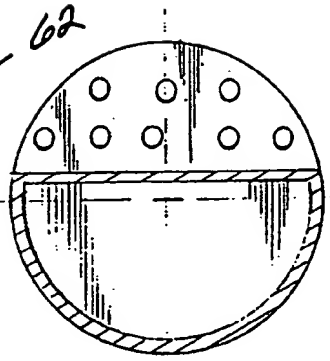


FIG-8 63

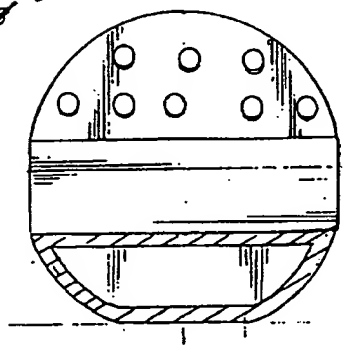
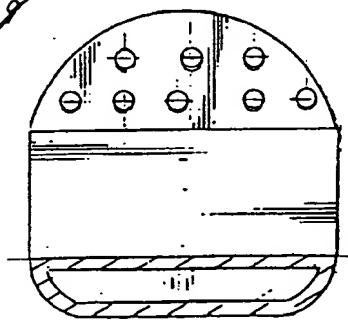


FIG-9 64



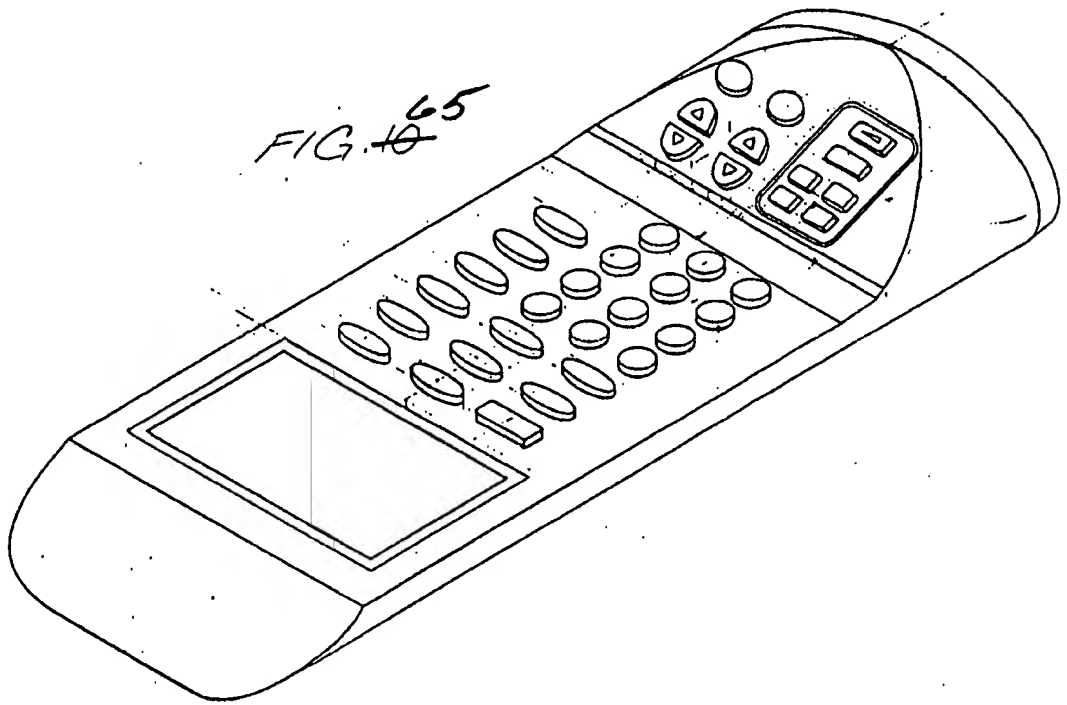


FIG. 65

FIG 66

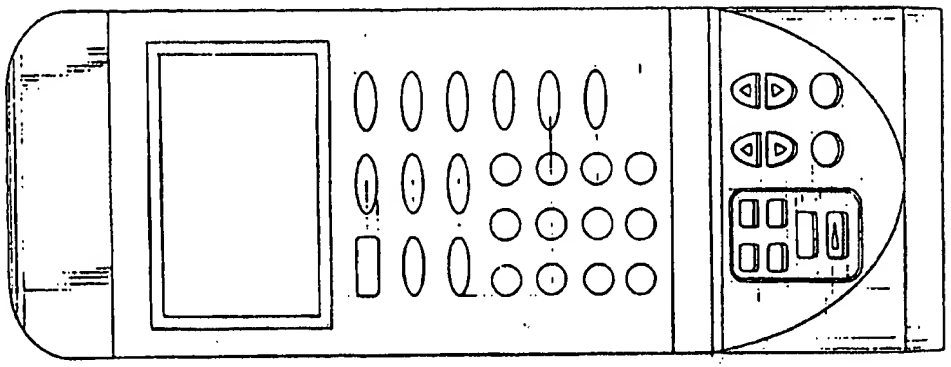


FIG 67

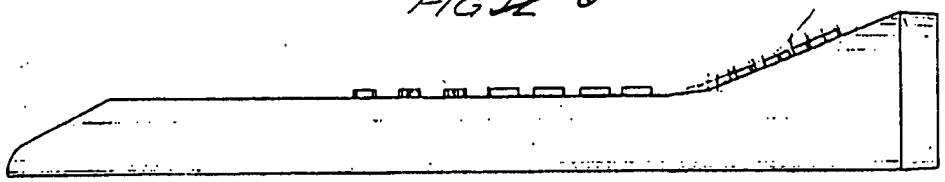


FIG. 68

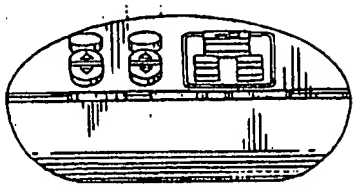


FIG. 69

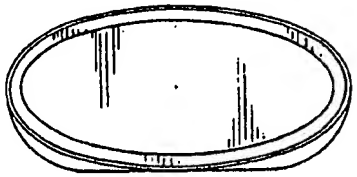


FIG. 70

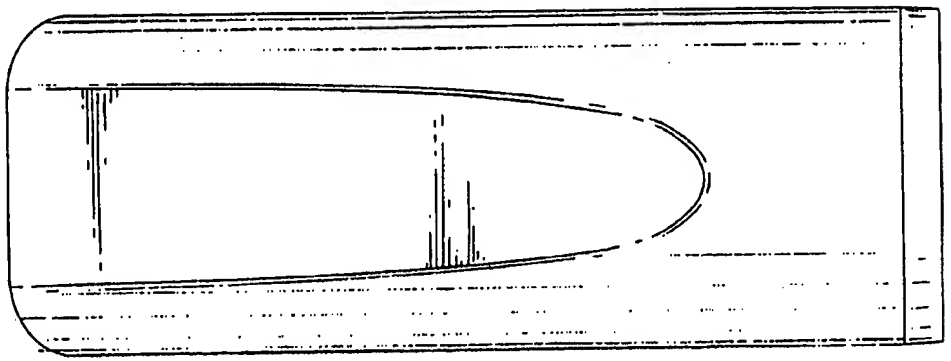


FIG. 16

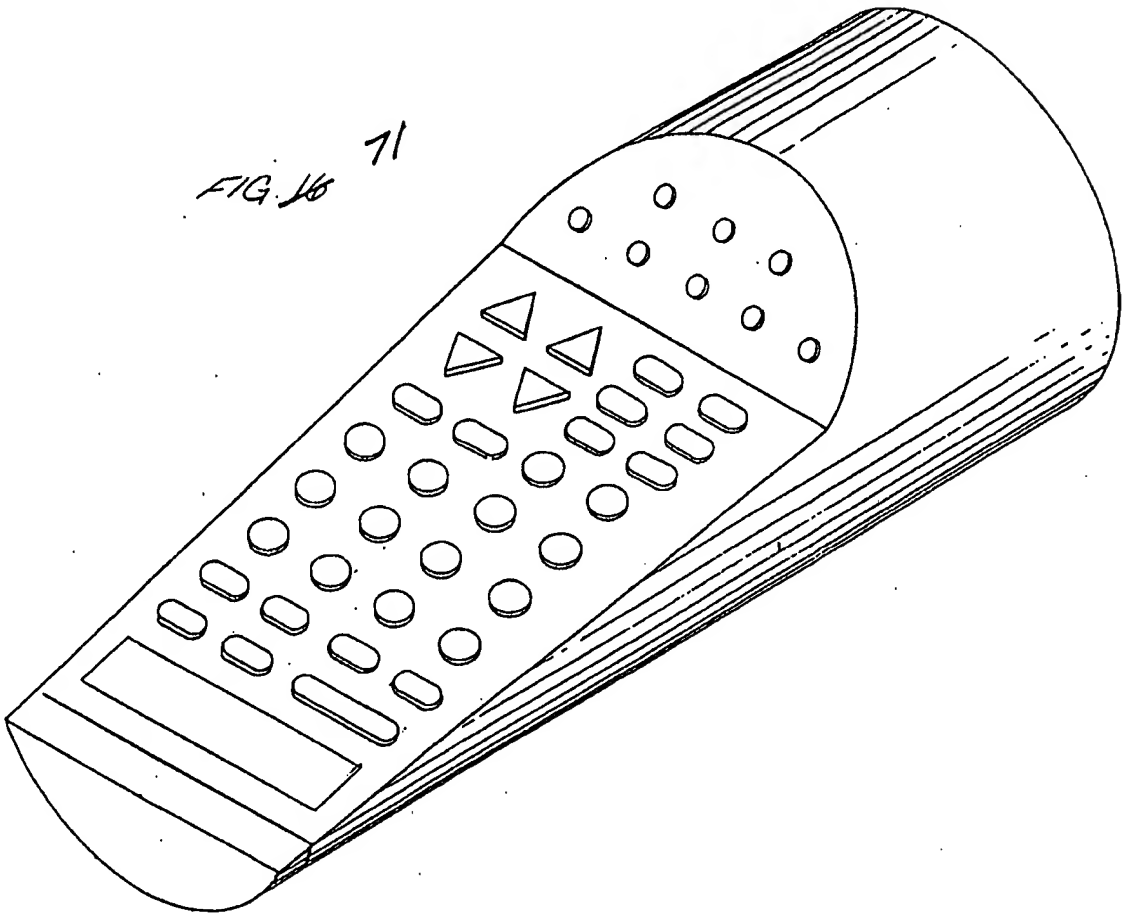


FIG. 12

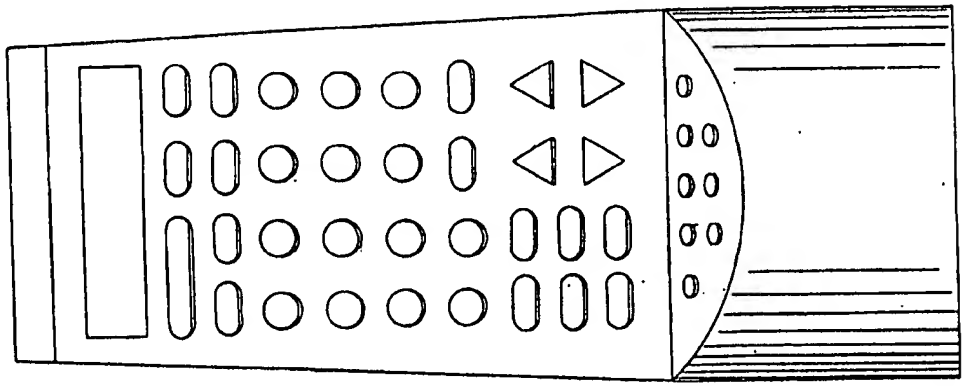


FIG. 13

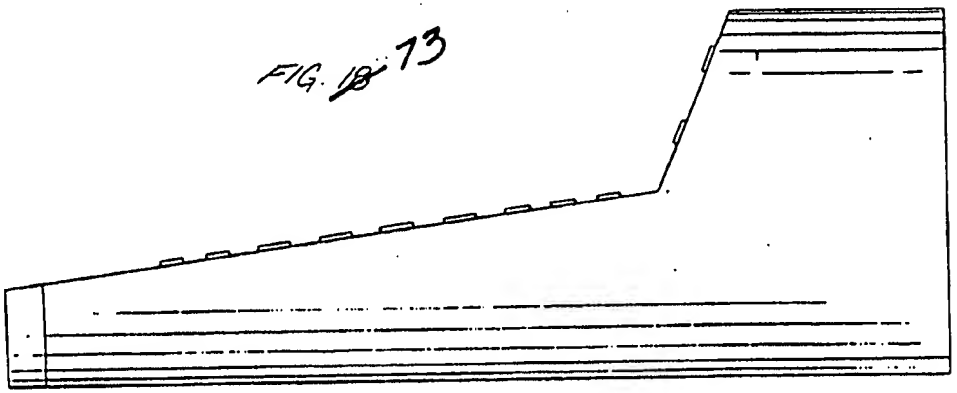


FIG. 19 74

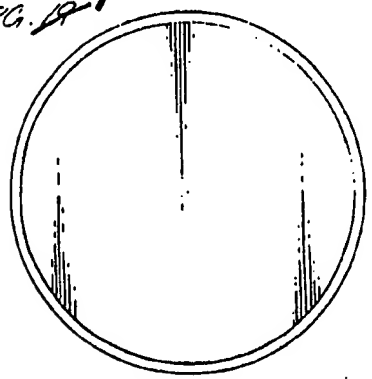


FIG. 20 75

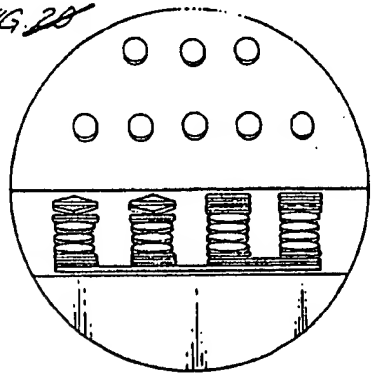


FIG. 21 76